Weatherwise

Volume 13, Number 2 April 1960

"SOME PEOPLE ARE WEATHERWISE BUT MOST ARE OTHERWISE"—BENJAMIN FRANKLIN

WEATHERWISE

THE MAGAZINE ABOUT WEATHER

DAVID M. LUDLUM, *Editor* HENRY W. BULKLEY, *Associate Editor*

U.S. ORBITS WEATHER SATELLITE; IT TELEVISES EARTH AND STORMS; NEW ERA IN METEOROLOGY SEEN

This headline in *The New York Times* announced the successful launching of Tiros I, a 270-pound satellite, at Cape Canaveral on 1 April 1960. The two television cameras on Tiros I are expected to transmit photographs of the Earth's cloud cover for a three-month period. The present "weather eye" is considered a prototype of future space vehicles which will provide 24-hour, world-embracing data for weather forecasters. Readers of *Weatherwise* will recall the article by Dr. Sigmund Fritz of the U. S. Weather Bureau in the August 1959 issue: "On Observing the Atmosphere from Satellites—I. Cloud Observations." Dr. Fritz had planned a second article for the present issue, but so rapid has been the progress in the field that it was decided it would be better to postpone the article to a future issue when a digest of the experiences with Tiros I could be presented.

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Front Cover: An aerial photograph taken over San Francisco Bay looking northwestward with Mt. Tamalpais in background. The west end of the Bay Bridge and a portion of downtown San Francisco are in center and left center. The Fleet is shown moving out of a tongue of the ocean fog bank which obscures the Golden Gate Bridge and then turning southward past the San Francisco waterfront. Official Photograph, U. S. Navy.

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The Central San Francisco Bay Area as seen from the Berkeley Hills. Photo by R. L. Copeland, courtesy the Berkeley Chamber of Commerce.

San Francisco, the Air-Conditioned City

HALBERT E. ROOT, *U. S. Weather Bureau, Airport, San Francisco, California*

SAN Francisco is noted for its cool summers and mild winters. In fact its mean summer temperatures are lower than those of any other large city in the United States. In July the average maximum temperature is a cool 64 degrees, while in September, the warmest month at San Francisco, maximum temperatures average a comfortable 68 degrees. In the San Francisco Bay Area as a whole, average summer daytime temperatures on the east side of the coastal hills show a progressive increase with distance from the City of San Francisco, giving a wide choice of summer temperatures within easy driving distance of the city.

The San Francisco Bay Area owes its mild climate to its particular location on the eastern shores of the Pacific Ocean and to its topography which combine to provide what amounts to a built-in air-conditioning system. The air-conditioning system is coupled to one of the dominate features of the general circulation—the Pacific Anticyclone. This giant clockwise circulation, which is a prominent feature of the normal sea level maps, reaches its maximum extent in mid-summer when it

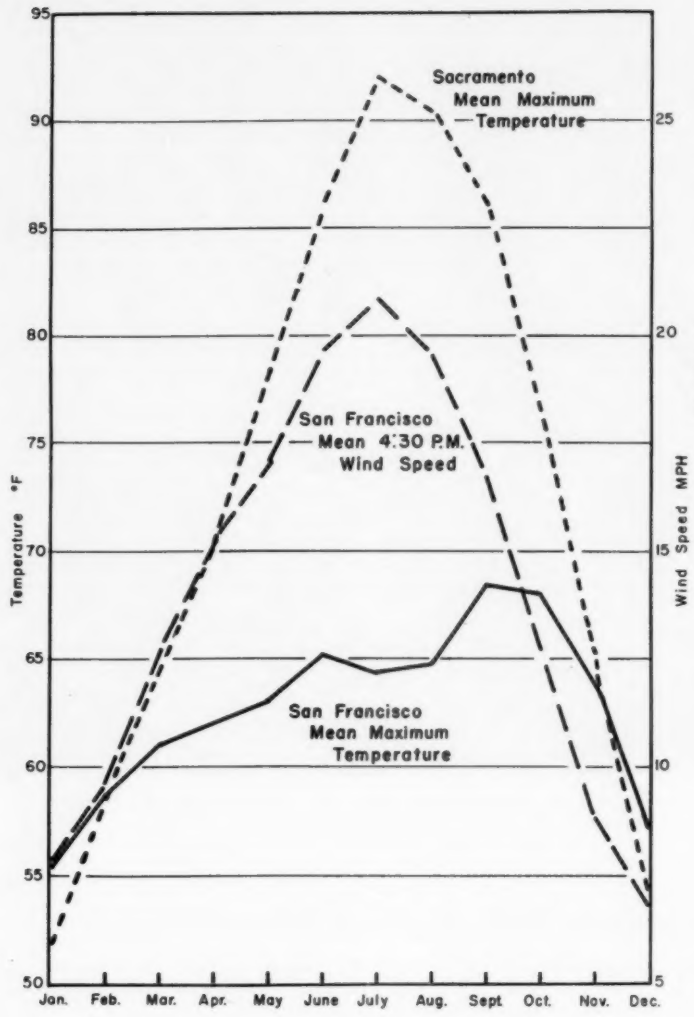


FIG. 1. Mean wind speed curve for San Francisco and mean maximum temperature curves for San Francisco and Sacramento.

covers most of the North Pacific Ocean. As the Pacific High or Anticyclone builds up in summer, the heat low in southwestern desert regions deepens, providing an average onshore pressure gradient in the vicinity of San Francisco that reaches a value of about 3mb/.10" per 100 miles in the peak month of July. This gradient provides the driving power for the prevailing onshore flow.

A good air-conditioning system requires a cooling mechanism as well as a good flow of air. As the Pacific High builds up with the coming of summer, strong northwest winds begin to blow down the California coast. These persistent strong winds drag the surface water with them, forming the southward flowing California Current along the California coast. As meteorologists well know, any free-flowing fluid on the earth's surface tends to curve to the right in the northern hemisphere in response to the action of the Coriolis force. As the California Current veers to the right away from the coast in response to this force, the warmer surface wa-

ter along the coast is replaced by cold water welling up from the ocean depths. This cold water provides a cooling mechanism to modify further and condition the marine air as it moves inland.

The operation of San Francisco's air-conditioning system is completely automatic. As the Pacific High and the desert heat low build up to their maximum extent in July—the hottest month of the year in less fortunate areas—both the onshore flow of air and the upwelling to cool and condition it reach their maxima. With the coming of winter and cooler weather the Pacific High shrinks in size, reducing the pressure gradient along the California coast. Upwelling ceases as the driving northwest winds diminish and the prevailing onshore flow is reduced to a gentle breeze just sufficient to provide a moderating effect on the cooler temperatures of the winter months. Hence the system automatically adjusts itself to give the maximum cooling in the summer and warming in the winter. The air-conditioning system adjusts itself also to the diurnal variation in temperature. As inland areas heat up rapidly during the day, the increasing temperature difference between the air over inland areas and the air over the cool coastal waters increases the onshore flow. Thus the cooling onshore flow is greatest during the heat of the day and least during the cool early morning hours.

The overall seasonal effect of this air-conditioning system is graphically illustrated by the curves of figure 1. The normal seasonal increase in the mean maximum temperatures at San Francisco is retarded during the summer months as the mean afternoon wind speeds increase in force. The moderating influence of the sea breeze can be appreciated better by reference to the temperature curve for nearby Sacramento where the effect of the sea breeze is small. In July the mean maximum temperature is 28 degrees cooler, and in January the mean minimum temperature is 7 degrees warmer than at Sacramento, 70 miles inland.

Breakdowns in the air-conditioning mechanism occur occasionally and then temperatures soar far above normal. These breakdowns are most apt to occur in June or in September when the system is operating below its peak mid-summer efficiency. They are generally associated with the movement inland over the Pacific Northwest of a lobe of the Pacific High, causing a reversal of the normal onshore gradient and bringing a temporary halt to the cooling sea breeze.

In the summer the air aloft flowing down the eastern side of the Pacific High is warmed and dried by subsidence on its southward journey, while the surface air is cooled by contact with the cold upwelling waters along the California coast. This warming from above and cooling from below acts to build and maintain the strong inversion that caps the cool marine air along the California coast. Most of the onshore pressure gradient and the strong onshore flow are confined to this cool layer of marine air which averages about 1500 ft in thickness.

Normally winds increase with height above the earth's surface, but the highest wind speeds in the strong summer onshore flow along the California coast are usually found at or near the surface, while the winds above 2000 ft are generally quite light. One can, on occasion, cross the Golden Gate Bridge in cool, foggy, 58-degree weather with 25 to 30 mph westerly winds and, on driving up Mt. Tamalpais a few miles to the north and 2000 ft higher, find clear 85-degree weather and very light winds. The bridge and the city below are wrapped in a white blanket of fog that laps against the mountain side at one's feet, with Mt. Diablo, Grizzley Peak, and the higher peaks of the coastal mountains poking through like dark islands.

The coastal mountains of California are high enough in most sections to form an effective barrier against the penetration inland of the cool marine air. It is only in a few favored places, such as the San Francisco Bay Area, that this barrier is low enough to permit the free flow of cool air inland (figure 2). In these favored places the cool air below the inversion pours inland, tending to follow the topography like a broad river. The flow is swift where the channel narrows and slow where the channel widens, with eddies and backwashes around obstructing ridges and islands. When the inversion is low the flow follows very closely the channels of the bay and rivers. As is illustrated in figure 3, it sweeps in through the Golden Gate, splitting at Alcatraz into two main streams with one stream curving southward toward the southern Bay and the other northward over the

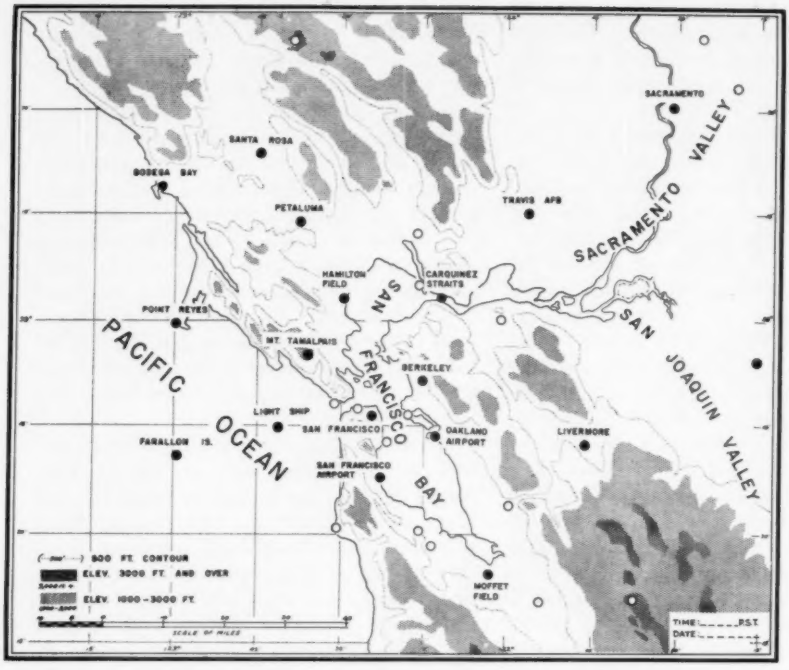


FIG. 2. General topography of the San Francisco Bay area.

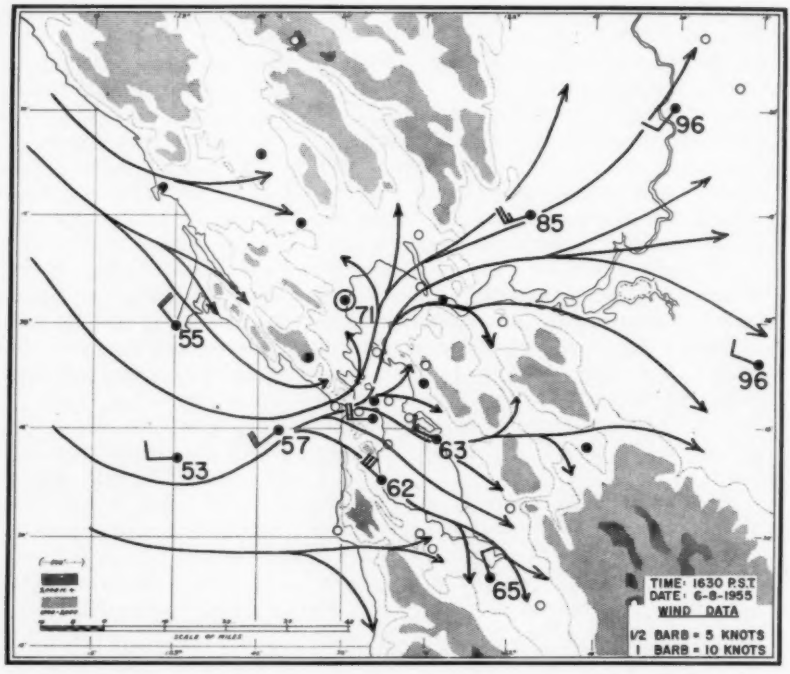


FIG. 3. Generalized afternoon flow pattern of marine air in the San Francisco Bay Area under typical summer conditions. The observed temperatures at 1630 PST are entered to illustrate the cooling effect of the sea breeze.

northern Bay and then eastward through the Carquinez Straits. After this it fans out into the great Central Valley with part flowing northward up the Sacramento Valley and part southward up the San Joaquin Valley. The observed temperatures at selected locations have been entered on this chart to illustrate the cooling effect of the sea breeze.

When the inversion is high, the flow of marine air cascades over the lower ridges and hills and pours through the passes following the more general topography of the area. The cool air stream is broader as it fans out over the bay and winds its way through the Carquinez Straits and over the lower passes into the great Central Valley.

As happens on occasion, the Pacific High builds sharply along the California coast at the same time that a deep low pressure system forms in Nevada setting the stage for a great increase in the onshore winds. Then wind velocities may reach gale force in many exposed locations and the flow becomes northwest over most of the Bay Area, as is illustrated in figure 4. The flow no longer splits at Alcatraz, but instead streams inland over Bodega Bay to the north and down the Petaluma Valley where it splits with part flowing southward over San Francisco Bay and part eastward into the great Central Valley. Even on a day such as this, however, the strongest winds are generally found near the surface. For all levels below 5000 ft. the afternoon sounding at Oakland showed speeds less than 10 knots with the exception of the 15-knot wind at the surface.

The flow patterns illustrated in figures 3 and 4 are only two of many recognizable wind patterns in the Bay Area. C. L. Smalley, in a detailed study of general wind flow, classified the patterns into eight basic types and many subtypes. This classification system was used for several years in conjunction with a meteorological advisory program for the California State Civil Defense Agency.

There is also a strong diurnal variation in the wind flow. Figure 5 illustrates the mean diurnal wind speed curves in June for three Weather Bureau stations in the Bay Area. San Francisco International Airport has the

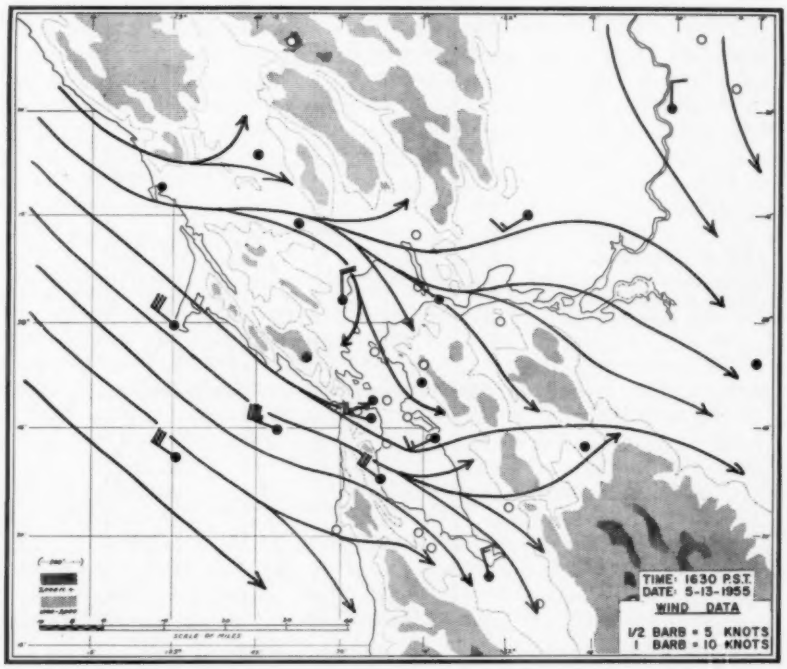


FIG. 4. Generalized afternoon flow pattern in the San Francisco Bay Area under conditions of strong northwesterly flow.

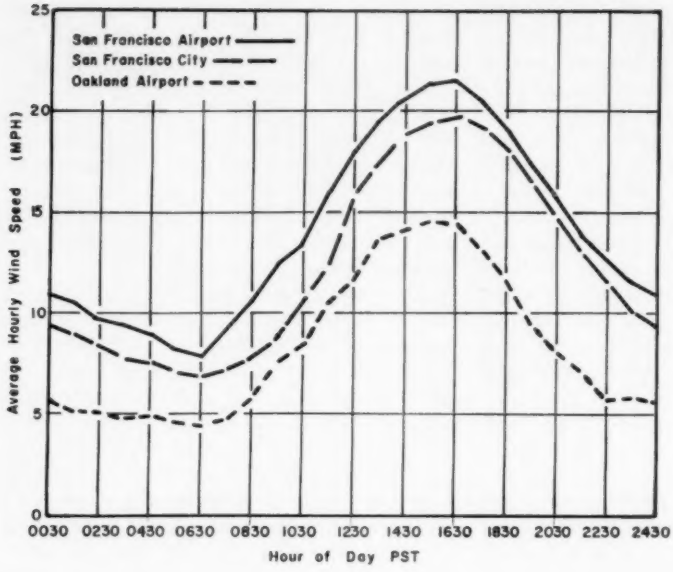


FIG. 5. Mean diurnal wind speed curves for the month of June.

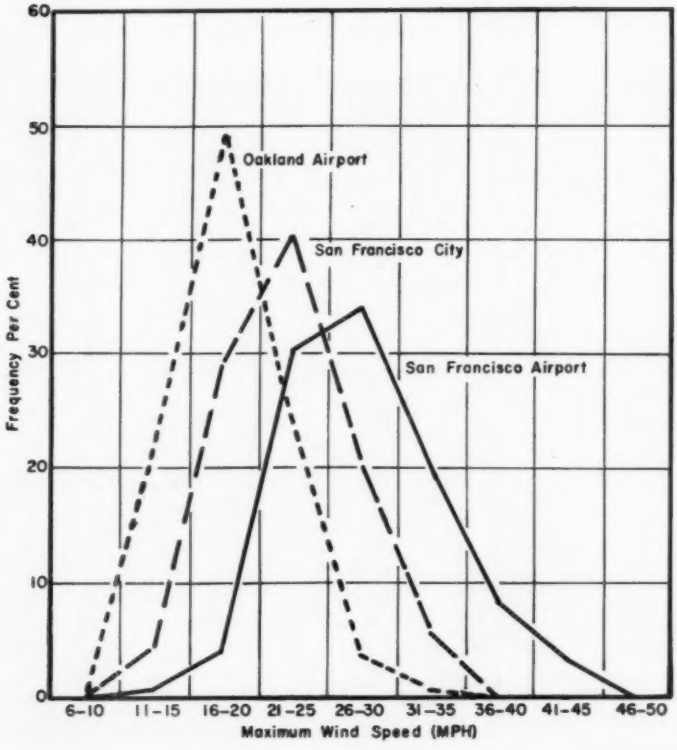


FIG. 6. Frequency distribution of daily maximum winds in May and June, 1954 through 1956.

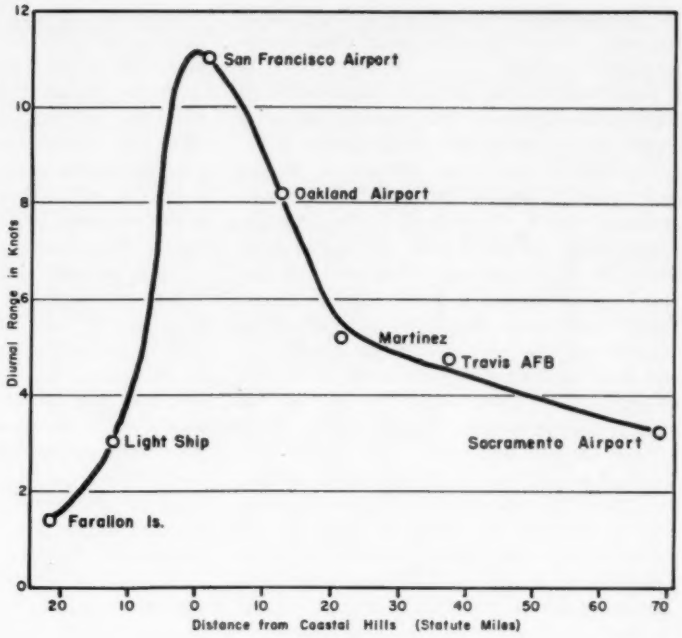


FIG. 7. The variation in diurnal range with distance from the coast as measured by the average increase in wind speed from 0430 PST to 1630 PST. May and June, 1954 through 1956.

highest mean speeds of the three because of the funneling effect on northwest winds of the nearby northwest-southeast orientated pass. The mean speeds at the city office are a little lower because of the less favorable orientation of the pass through the Golden Gate and because Mt. Tamalpais to the northwest gives some shelter from strong northwest winds. The mean speeds at Oakland are the lowest of the three because of the general slackening of the flow as it fans out over the broad expanse of San Francisco Bay. A similar relation holds for the distribution of the daily maximum wind speed at these three stations. This is illustrated in figure 6 which shows a progressive increase in the modal maximum wind speed from the 16–20 mph group at Oakland Airport to the 26–30 mph group at San Francisco International Airport.

The variation in diurnal wind speed around the Bay forms a very interesting pattern. The difference in mean wind speed between the slack early morning flow and the vigorous afternoon flow is greatest near the coastal hills, decreasing rapidly both inland and seaward. This is illustrated in figure 7 where these differences are projected on to a line normal to the coast extending from the Farallon Islands to Sacramento. The diurnal range, as measured by the difference between the 0430 and 1630 mean wind speeds, varies from a minimum value of about one knot at the Farallon Islands to a maximum of about eleven knots near the coastal hills. It then falls off rapidly with distance inland to about three knots at Sacramento Airport.

Boating is becoming an increasingly popular sport on San Francisco Bay. Sailing, in particular, has long attracted a rugged lot who brave the stiff winds and flying spray common to the choppy waters of the Bay. While boating on the Bay can be very exciting it can also be dangerous and each year takes its toll of venturesome souls with more courage than skill. The strong tidal currents that wash through the narrower channels of the Bay are added hazards. At the peak of the flow on a normal ebb tide the water is rushing out under the Golden Gate Bridge at a rate of about 4,600,000 cubic feet per second—about seven times the flow of the Mississippi River. When this flow is opposed by a 20 to 30 mph wind,

the channel under the bridge becomes a seething mass of foam that few small boat operators care to tackle.

San Francisco has long been famous for its large natural harbor. It is noted, too, as a center for air traffic with a constantly growing volume of freight and passengers. In this new age of jet-powered aircraft the cool temperatures and brisk winds of her natural air-conditioning system provide her with advantages for jet travel that rival those of her large natural harbor. These stem from two main factors: that the thrust of a jet engine depends directly on the density of the air, and that each knot of headwind on take-off means one less knot to be provided by the plane's engines to reach flying speed.

Each airport used for commercial jet aircraft operations and each individual runway have carefully determined limits on the maximum gross take-off weight for each type of jet aircraft. These limits, which are determined under standard conditions of temperature and pressure and zero headwind, depend on the length of runway and on the height and location of obstructions in the path of the plane after take-off. As conditions vary from the standards under which the limits were set, corrections are applied to determine the specific maximum gross weight for any particular operation. On the most used jet runway at San Francisco International Airport, the maximum gross weight is reduced by 200 to 700 pounds (depending on the type of jet aircraft) for each degree Fahrenheit increase in temperature and is increased by about 500 pounds for each knot of headwind component. In order to illustrate the effect of the favorable winds and temperatures at San Francisco International Airport, the gain in allowable take-off weight based on the mean wind and temperature at San Francisco and a nearby inland location (Sacramento) has been computed. In July the mean temperature at San Francisco International Airport is 15 degrees cooler and the average hourly wind 3 knots stronger than at the nearby inland location. If other factors are held constant and these values are converted into pounds on the basis of 200 pounds per degree Fahrenheit and 500 pounds per knot of headwind, flights out of San Francisco International Airport enjoy an average potential advantage of 4500 pounds per flight. If computed on the basis of 700 pounds per degree Fahrenheit, the advantage is increased to about 12,000 pounds per flight.

We have seen that the benefits of San Francisco's air-conditioning system are many. It provides a cool invigorating climate in summer and tempers the chill of winter. It supplies the sailing enthusiasts with exciting sport to test their skill, and it allots substantial advantages to commercial jet aircraft operators. While the summer visitor from warmer climates may mutter about the control being set too low as he shivers in the 60-degree weather and brisk winds, the true San Franciscan loves his cool, foggy city and would not trade it for any other place in the world.

Fog rolling in from the ocean obscures the north tower of the Golden Gate Bridge as seen from the Waldo approach in Marin County. Photo courtesy San Francisco Chamber of Commerce.

Awards for Weather Bureau Cooperative Observers

J. H. HAGARTY, *Office of Climatology, USWB*

THE Weather Bureau has some 11,000 cooperative observers who take daily observations of precipitation, of temperature and precipitation, of river stages, etc. While these observers do their work without pay, a few receive small sums, frequently for special services such as telephoning weather reports as instructed.

The cooperative observer program has been in effect throughout the life of the Weather Bureau and for many years before. The value of the data collected throughout the years is

beyond measure. Many observers have served for long years, and some stations have been handed down from one generation to another in the same family. Recently the Weather Bureau announced a number of new awards for cooperative observers. These include the following:

1. *Award for Ten Years of Service.* This award is an attractive certificate depicting the standard Weather Bureau instrument shelter and rain gage. It will be given to each observer who completes 10 years of service.

2. *Emblems for observers who complete 15, 25, 30, 35, 40 and 50 years of cooperative observations.* These lapel emblems have recently been re-designed, as follows:

15 years—Bronze emblem with white enamel
25 years—Silver emblem with red enamel
30 years—Gold-filled emblem with blue enamel
35 years—Solid gold emblem with blue enamel and synthetic ruby
40 years—Solid gold emblem with blue enamel and 2-point diamond
50 years—Solid gold emblem with blue enamel and 3-point diamond

3. *Letters of commendation from the Chief of Bureau and Secretary of Commerce.* These letters have been sent for the past several years. Each observer who completes 40 years of observing, each one who completes 50 years of observing, and each one who retires after more than 40 years of observing receives a letter of appreciation from the Chief of the Weather Bureau and from the Secretary of Commerce.

4. *Special Service Award.* This is a certificate featuring the Weather Bureau seal. It will carry a citation indicating the services for which it is awarded to a particular observer.

It is issued to those observers who have rendered significant special services such as taking timely and unusual action to ensure receipt of weather observations at collection centers, or actions related to weather observing or reporting beyond the ordinary call of duty resulting in the saving of life or property.

These awards are to be made as soon as possible after the event for which the award is given.

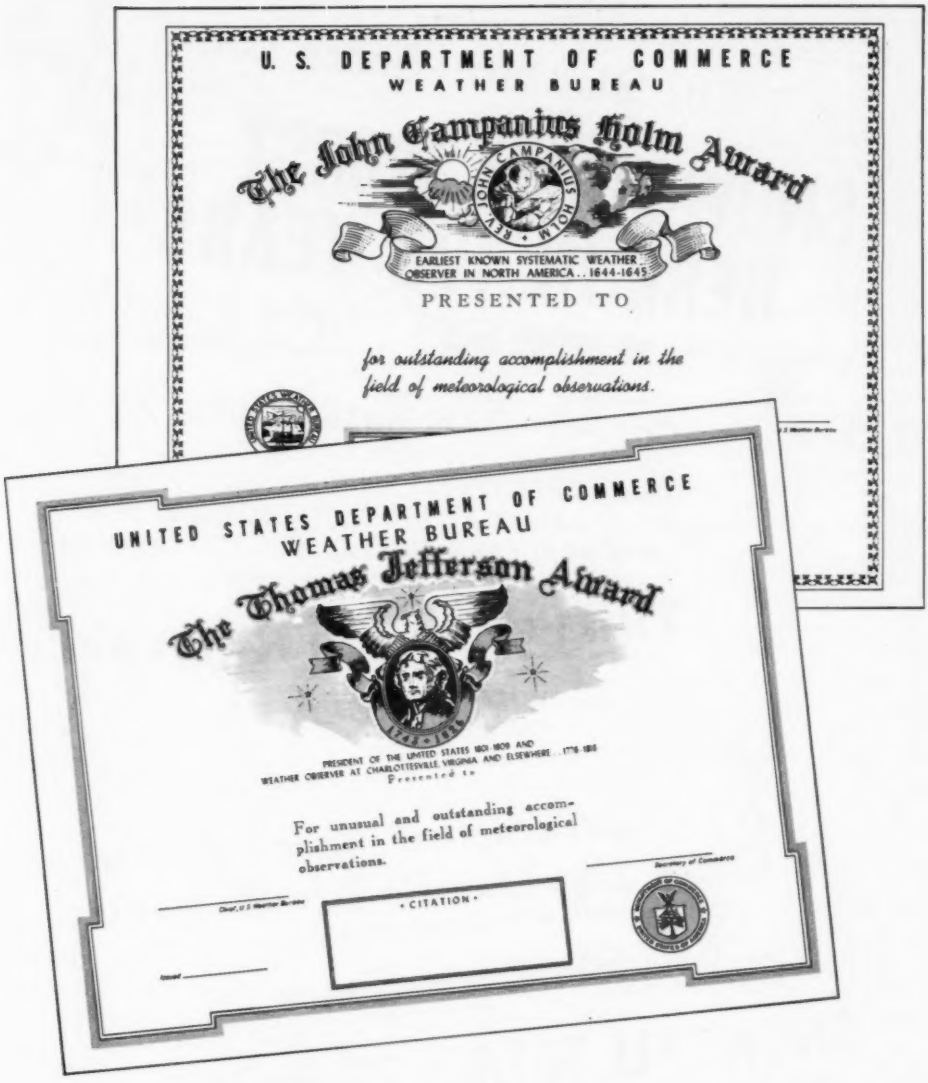
5. *Thomas Jefferson and John Campanius Holm Awards.* These are the two highest certificate awards available for cooperative observers. The most difficult to earn is called the Thomas Jefferson Award after the President who kept an almost continuous record of the weather from 1776 until the end of 1816, not only at Monticello, Virginia, but wherever he was located. The certificate, which carries the likeness of President Jefferson, outlines the services for which it is given and will be signed by the Chief of the Weather Bureau and the Secretary of Commerce.

The John Campanius Holm Award is named after the first known systematic weather observer in what is now the United States. The Rev. Holm, a Swedish chaplain, took daily observations without instruments at Swedes Fort, near what is now Wilmington, Delaware, for the years 1644 and 1645. See *Weatherwise,* October 1955, 116–17.

This certificate shows a colonial clergyman making entries with a quill pen. It will carry a citation and will be signed by the Chief of the Weather Bureau.

Approximately 5 Thomas Jefferson and 25 John Campanius Holm Awards will be issued annually. They will be given for service such as:

(a) Long record of observations without any missing data.
(b) Long record of unusually legible observations.
(c) Long record of unusually accurate observations.
(d) Taking or reporting observations under hazardous or extreme weather conditions.
(e) Unusual effort to maintain continuity of observations during illnesses or emergency absences.
(f) Unusual effort to ensure early receipt of data at collection centers.
(g) Long family history as cooperative observers.
(h) Unusual effort in disseminating published climatological data or in preparing papers on climatology.


U. S. DEPARTMENT OF COMMERCE
WEATHER BUREAU
The John Campanius Holm Award
REV. JOHN CAMPANIUS HOLM
EARLIEST KNOWN SYSTEMATIC WEATHER OBSERVER IN NORTH AMERICA . . 1644-1645
PRESENTED TO
for outstanding accomplishment in the field of meteorological observations.
UNITED STATES DEPARTMENT OF COMMERCE
WEATHER BUREAU
The Thomas Jefferson Award
PRESIDENT OF THE UNITED STATES 1801-1809 AND
WEATHER OBSERVER AT CHARLOTTESVILLE, VIRGINIA AND ELSEWHERE . . 1776-1826
Presented to
For unusual and outstanding accomplishment in the field of meteorological observations.
• CITATION •

6. *Award for Institutional or Organizational Cooperative Observers.* The Weather Bureau relies heavily on institutions and organizations to serve as cooperative observers in a great many cases. Some examples are factories, mills, nurseries, power plants, sewage plants, colleges and various municipal, state, and Federal governmental agencies. Many, but not all, of these cooperators have a need for weather observations. Some have taken observations for long periods of time.

This award is designed to recognize cooperative weather observing by institutions and organizations. It is a certificate showing an industrial scene, and will be given to institutions or organizations on completion of 25 years (or multiples of 25 years) of service as cooperative observers.

New Bedford, Mass., March 5 and 6, 1960

New Bedford, Mass. March 4, 1960

The Great Early March Snowstorm of 1960

DAVID M. LUDLUM

ONE of the great snowstorms of modern times staggered southeastern New England on 3–5 March 1960 as a coastal northeaster, swirling up from the Hatteras region, hesitated in its poleward dash for a few crucial hours southeast of Cape Cod. The pause in this area of convergent ocean currents and air streams was accompanied by a marked intensification of the whole storm structure. As a result, the precipitation process kept going several hours longer than is usual with a steadily-moving storm, and record amounts of frozen moisture fell over Rhode Island and eastern Massachusetts.

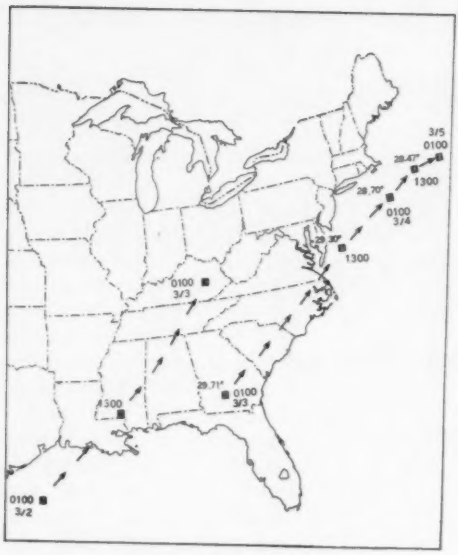
The Logan International Airport station of the Weather Bureau, at sea level along Boston Harbor, measured 19.7″ of new snow, to exceed by 0.3″ the former record (1872–1960) for a single Boston storm, which, by the way, was set as recently as February 1958. Precipitation fell even heavier south of Boston, closer to the storm center. Snowfall depths up to 30″ were reported by cooperative observers of the Weather Bureau, and Nantucket Island had a mixed precipitation total of 3.85″ of water.

Residents of the Boston area had been congratulating themselves on their mild winter (February's lowest temperature was 20° and only 2.3″ of snow fell in the usually snowiest month), while more southerly latitudes were getting an extraordinary share of white flakes and cold. But on the final day of February the mercury dropped below the date normal, destined to remain there for an extended period as a large Arctic air mass, poised over the northern Plains States and the Prairie Provinces, gradually extended a long encircling finger of cold dense air eastward to the northern Atlantic seaboard. The establishment of a core of cold air over northern New England and the Maritime Provinces was to play an important role in the subsequent development of a storm situation some 1500 miles distant in the Gulf of Mexico.

During February an active storm track carried several disturbances from the Southwest across Texas and thence northeastward through the Lower Lakes, placing the North Atlantic States in the warm sector to be buffeted by rains and gales but no snow. Another of the series of disturbances was organizing in the complicated low pressure area over the Southwest and northern Mexico on March 1st. Early on the 2nd a definite wave on the polar front in the western Gulf of Mexico increased the intensity of precipitation already falling over Texas northwestward to the Rockies in conjunction with the low pressure feature over the Southwest. By noon of the 2nd two significant developments appeared on the weather map: the Gulf wave had progressed northeastward to the Louisiana coast, and the Plains anticyclone had strengthened its position by pushing a ridge southward to Texas and tightening the pressure gradient on the west side of the low pressure trough now pointed northeastward toward New England. Another 12 hours (1300/2nd-0100/3rd) found the low center in east-central Kentucky with a precipitation shield covering the South Atlantic States and reaching as far north as Washington, D. C., and thence westward to Iowa.

At this point, the low over Kentucky, caught as it was between two pincers of the northern anticyclone, slowed markedly and began to fill as rapidly-falling pressures over Georgia and the Carolinas announced the formation of a secondary circulation in southern Georgia. Cold rain was falling in the Augusta-Charleston latitude, but farther north a steady freezing rain caused a sheath of glaze to increase hourly. Moderate to heavy snow had already reached considerable depths over southern Virginia as Gulf air with great moisture content was carried by a vast southwesterly flow aloft over the cold northeasterly stream at the surface flowing out of the North Atlantic Coast high pressure ridge. Roanoke in southwestern Virginia had 12 inches of new snow on the ground at 0100 on the 3rd with the northern limit of snowfall at that hour close to Delaware Bay and along a Wilmington-Pittsburgh axis.

As expected by forecasters, the secondary



The storm situation on 2–5 March 1960. Location of centers are shown at 12-hour intervals; time is Eastern Standard; estimated barometric pressures are in inches.

rapidly became the major circulation and heavy snow warnings were issued for the Middle Atlantic States and much of New England. The new low made a quick move northward in the next 12 hours (0100–1300 /3rd) to emerge into the Atlantic Ocean between Hatteras and Norfolk, standing about 100 miles off the Maryland shore about 1300. The precipitating clouds had then reached all the way to Connecticut and southeastern New England with a heavy snow band in an arc from eastern Pennsylvania to Nantucket already in action.

The fast development of the low and its quick movement northeastward seemingly indicated an energetic, fast-moving storm would brush the New England coast and push beyond. But at this point the encircling arm of the surface anticylone, backed by an upper-air ridge extending southward into the Atlantic from Nova Scotia, began to apply a restraining force on the low. The 12 hours (1300/3rd–0100/4th) brought a remarkable increase in its energy, transforming an ordinary coastal depression into a giant among snow-producing storms of the present century. As the resisting wall of high pressure applied the brakes to the forward progress of the low, such was the deceleration that the center moved only 225 miles northeastward from 1300/3 to 0100/4, though deepening in that time by 20 mb/.60″ to an estimated central pressure of 972 mb/28.70″ when about 100 miles south of Nantucket. Heavy snow had now been falling over southeastern New England for 12 hours.

The succeeding 12 hours moved the low center even less, about 180 miles, along a northeasterly track, a rate of about 15 mph compared with a 30–40 mph rate common to coastal storms in this latitude. A further deepening dropped the central pressure to an estimated 964 mb/28.47″. Nantucket's lowest barometer of 28.79″ came at 0642 on the morning of the 4th when the center was at its closest approach, about 80 miles to the southeast.

The accelerated circulation attending the deepening of the low raised whole gale force winds along the shoreline where the near-hurricane wrought great havoc on snow-laden electric power lines, especially those running crosswise to the prevailing northeasterly and northerly flow. Most of the widespread power failures came on the morning of the 4th after the winds had backed to north and increased to a gusty 40–50 mph as the low continued to deepen. The Early March Storm of 1960, however, is noteworthy not for high winds or storm tide, but for its excessive snowfall—so let us turn to a consideration of that phase.

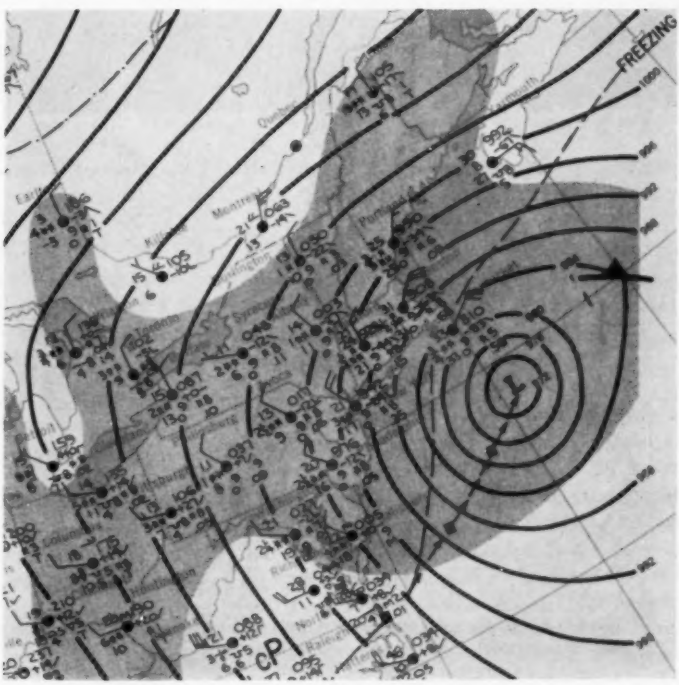
In the South a mixture of precipitation had fallen as the Gulf of Mexico wave moved northeastward, and this intensified with the development of the secondary in Georgia. Along the western flank of the new storm in the southern Appalachians, the form varied from cold rain, to freezing rain, sleet, and snow according to elevation and latitude. Northern Georgia and southeastern Tennessee experienced a crippling covering of glaze as much as one inch thick. In the mountains of North Carolina and Virginia, already beset by record February snows, up to 18″ of new snow completely isolated many mountain towns. Roanoke added 17.4″ to its already impressive winter total. The heavy snow belt included much of West Virginia and west-central Maryland, but along the coastal plain Washington's 8-inch fall was representative of amounts in city areas from Richmond to cen-

tral New Jersey. Paralleling the track of the low at a distance of about 200 miles, the heavy snow belt swung northeastward across eastern Pennsylvania (up to 17″ new snow), northern New Jersey (22″ maximum at official stations), and into southeastern New York.

In the New York City area, C. G. Knudsen of the Weather Bureau, has forwarded the following summary: "Snow began at 0625, Thursday the 3rd, at the downtown Weather Bureau office and continued for over 24 hours to 0815 on Friday by which time 14.2″ were recorded—the heaviest fall since the 16.7″ on 19–20 December 1948. Actually all the precipitation had fallen before 0700 Friday. Measurements at this time by 18 cooperative observers scattered throughout the metropolitan area show a dozen readings bunched in the 14″ to 18″ level, with the other scattered from a 9″ total at Hightstown, central New Jersey, to 27″ at Dobbs Ferry, on the Hudson River north of the city. Due to the re-intensification on the morning of the 4th, some snow continued over Long Island and did not stop over the eastern half until mid-day Saturday, the 5th. The additional amounts after Friday morning were in the 4″–6″ range." Suffolk County Air Force Base reported a total fall of 23″ and Richard G. Hendrickson had 21″ at Bridgehampton, an easterly cooperative station on Long Island.

North of New York City the heavy snow band cut across southeastern New York. Ernest Johnson, New York State climatologist at Albany, telephoned an early report that Tannersville, a famous snow spot at 1950-feet in the Catskill Mts., had counted 44″ of new snow to boost the snow cover to 72″. Amounts in the Hudson Valley, as usual, varied greatly: from the reported 27″ at Dobbs Ferry in the south, to Poughkeepsie's 9″ in the central part, to Albany's 12.6″ in the north. Stewart Air Force Base near in the highlands near West Point had 17″—about the same as reported in the valleys of the Berkshires to the east: Great Barrington, Mass. 15″, and Bennington, Vt. 14″. Norfolk at 1350′, usually Connecticut's snowiest reporting station, turned in 21″.

For New England, the area climatologist, has written in the *Weekly Weather and Crop Bulletin:* "In the 36 to 40 hours that the

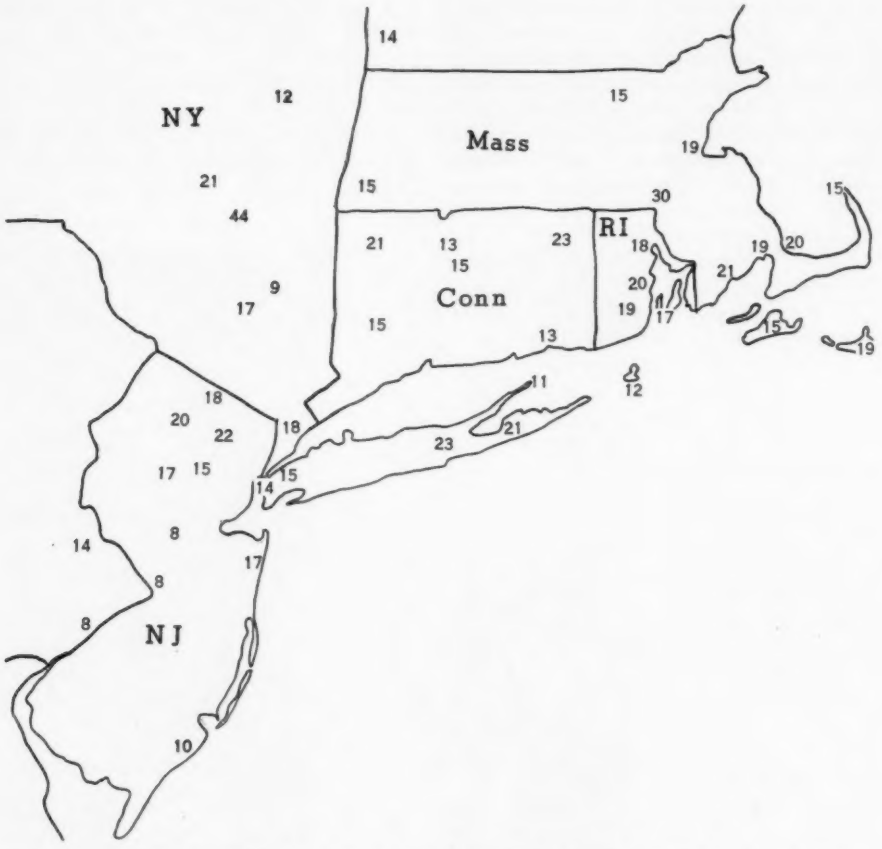


The surface weather chart at 0100 EST, 4 March 1960. The low is centered south of Nantucket Island with pressure estimated at 972 mb/28.70″. Forward speed had slowed to about 18 mph. Snow had been falling at New York City for 18 hours and at Boston for 12 hours.

storm affected New England it produced more snowfall over parts of eastern and southeastern Massachusetts, including Cape Cod, than any other storm in Weather Bureau records for those areas. Attendant gale winds, sometimes gusting to hurricane force, whipped the snowfall into drifts locally 10 feet or more, which contributed largely to the crippling effect of the storm. Total falls over southeastern New England ranged from 20 to 30 inches. These diminished to around 10 to 14 inches over central New England and western parts of southern New England and to less than an inch over extreme northern areas. Boston's total of 20 inches (19.7″) is an all-time record fall for a single storm in any month and represents a total greater than that previously accumulated in the current season."

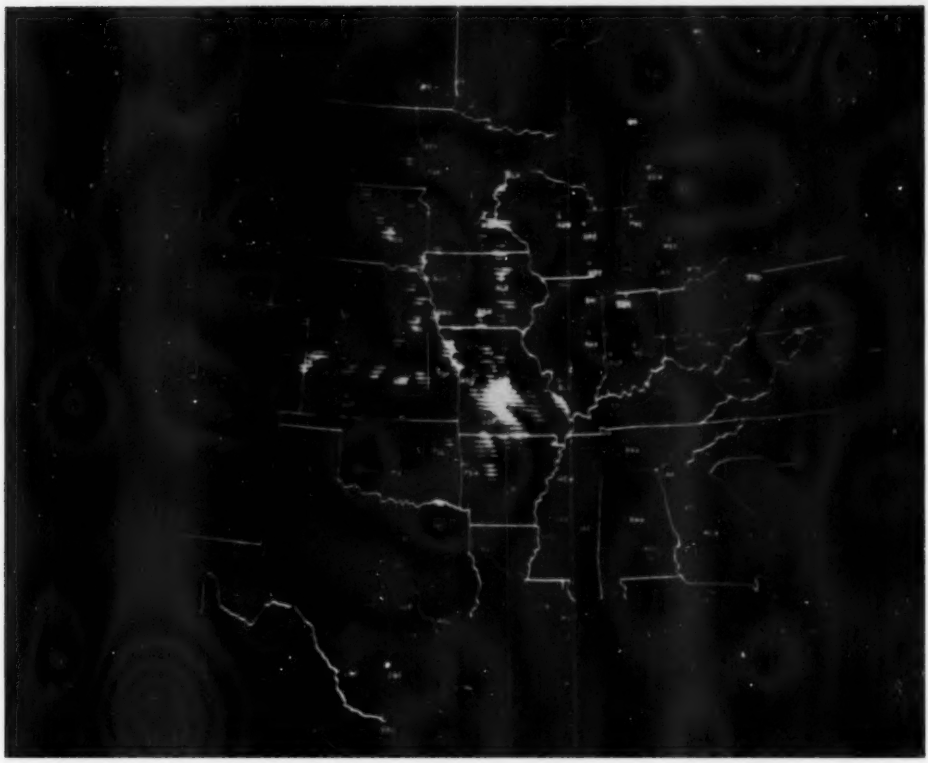
The measurements on Nantucket Island, the closest land station to the center of the storm, reveals much about the nature of the precipitation. A preliminary check indicates that 3.85″ of precipitation fell there. Snow commenced early in the forenoon of Thursday, the 3rd, and continued, often at a heavy rate, until 0145 on the 4th just after a depth of 11″ on the ground had been measured. A mixture of snow and rain then fell until 0350 when it turned to all rain and continued till 0620, shortly after which a check showed the snow cover reduced to 5″. But with the wind backing toward north as the lowest pressure was reached, snow commenced again and the cover

(*Continued on page 73*)



Snowfall depths for period 2–5 March 1960 in inches according to a preliminary survey by *Weatherwise* as reported by cooperative observers and state climatologists of the U. S. Weather Bureau. Complete figures will be published in *Climatological Data* for the states.

New Weather Warning System Under Test



A NEW automatic weather system which pinpoints lightning discharges from severe electrical storms over most of North America is now under test in the central parts of the United States.

The new system can detect lightning discharges at a distance of 2000 miles and relay the information to a central collection point. The equipment, which was developed by the U. S. Army Signal Research and Development Laboratory at Fort Monmouth, New Jersey, will be operated by personnel of the Air Weather Service, U. S. Air Force. It represents a further development of the "Sferics" system which was brought into practical use for the first time during World War II.

The central station will be located at Kansas City, Mo., and the six auxiliary lightning detector stations at Tinker Air Force Base, Okla., Fort Chaffee, Ark., Scott Air Force Base, Ill., and at civilian airports at Waterloo, Iowa, Huron, S. D., and Goodland, Kan.

The detector stations are equipped with special radio receivers which pick up static generated by lightning. Each station detects the discharges and almost simultaneously registers the time and compass direction, then relays the data to the central monitor at Kansas City.

An electronic device plots and displays on a special map of North America the position of the lightning within a tenth of a second after receiving the data. Thus, an operator, watching the map, can follow increasing electrical activity which might indicate developing thunderstorms and even tornadoes. It will be especially valuable in tracking electrical disturbances over ocean areas where there are no permanent observing stations.

SOUTH SLOPE

Some Microclimatic Temperature Differences At Yuma, Arizona

DESERT WASH

ARTHUR V. DODD, *Environmental Protection Research Division, Quartermaster Research & Engineering Command, Natick, Mass.*

A DISTINCTION must be made between standard weather observations taken primarily to meet the needs of the weather forecaster who must know the properties of large-scale air masses, and microclimatic measurements which are necessary if the climate of a given locality is to be studied. Temperatures in any particular area vary from the standard observations, the greatest differences occurring where strong incoming or outgoing radiation combines with favorable terrain situations to allow strong daytime heating or nighttime cooling. The requisites for the development of distinct microclimates are almost ideally found in the desert area of Yuma, Arizona. Summer incoming radiation is as intense as anywhere near sea level in the United States, and clear nights coupled with high surface temperatures allow for maximum nighttime cooling.

Previous articles in *Weatherwise* have stressed micro-temperature variations. In a survey of temperatures in a sixteen-mile cross section through Washington, D. C., Landsberg found horizontal temperature differences between downtown Washington and the suburbs up to 8° F during the day, and up to 11° F at night (1). Baum has discussed vertical differences in temperature near the ground. As an example he pointed out that the mean August temperature three inches above the ground at Burlington, Vermont, is the same as the mean August temperature at the standard height at Reading, Pennsylvania, although the average temperature at the standard height is 5° F higher at Reading (2).

At the request of the U. S. Army Quartermaster Corps, a Signal Corps meteorological team at Yuma Test Station, Arizona, took microclimatic observations for a two-year period at sites representative of characteristic types of desert surface. This was one phase of a broad program to investigate the climate of the lowest layer of the atmosphere in extreme environments. Examples of the most distinct differences in temperature regimes at Yuma Test Station, Arizona, are illustrated and discussed here.

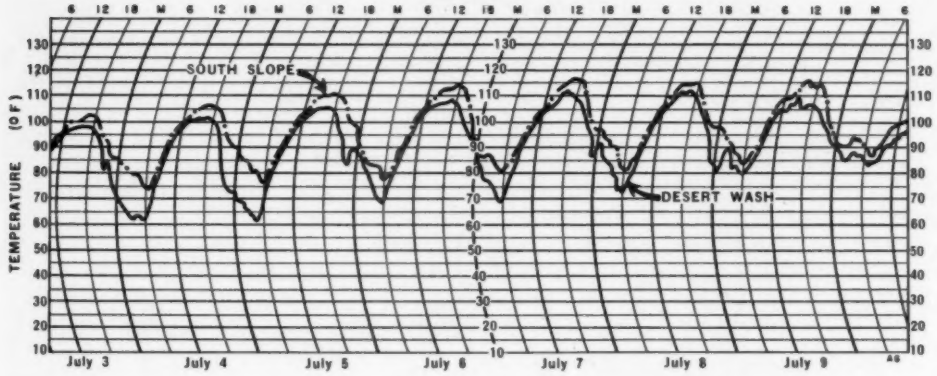
Figures 1 and 2 are temperature traces from thermographs which were housed in standard instrument shelters at two sites; one on the south slope of a 200-foot hill, and one five miles distant and 50 feet lower in a desert wash (see illustrations). The records at the two sites were slightly smoothed from the original charts, and placed on the same chart for a summer and a winter week, so as to make the temperature differences evident. The drainage of cooler air into the wash area is apparent. Minimum temperatures in the wash range from 5° F lower on 9 July 1956, a mostly cloudy night, to 21° F lower on 27 December, a clear night.

In summer maximum temperatures on the south slope averaged 5° to 8° F higher than in the wash. Maximum temperatures are approximately the same in winter.

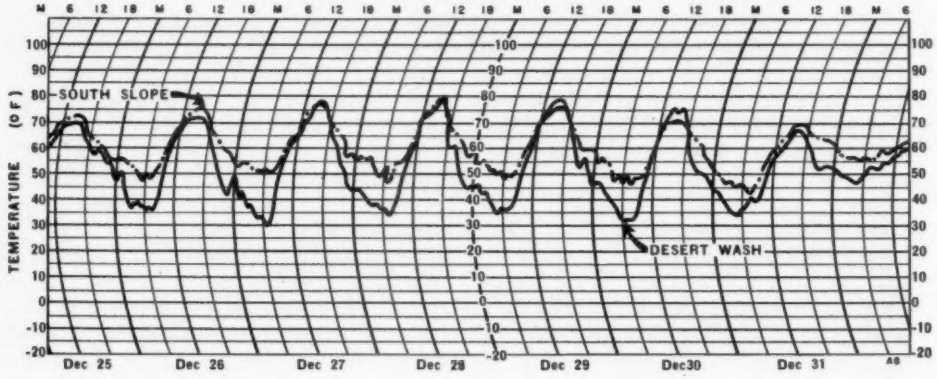
The Yuma area is noted for its year-round irrigation agriculture. The importance of proper selection of agricultural land is illustrated by the fact that in the 1956–57 winter freezing temperatures in the wash occurred as late as 16 March and as early as 4 November, while on the slope the absolute minimum at the standard level was 32° F, occurring on 17 February. An interesting feature of the cold air drainage period is the sudden increase in temperature which occurs when an increase in wind mixes the shallow layer of cold air, and warmer air displaces the cool surface layer. On 9 July such mixing occurred about 0300 at the wash station and the temperature rose 10° F to a value as high as at the slope station.

Vertical temperature measurements were made by the Signal Corps at ten levels between 200 centimeters height and 25 centimeters depth at a level sandy site designated "Sandy Plains." Continuous measurements utilizing thermocouples and chart recorders

TEMPERATURES DURING A SUMMER WEEK AT A SOUTH SLOPE SITE
AND A DESERT WASH SITE, YUMA TEST STATION, ARIZONA
JULY 1956



TEMPERATURES DURING A WINTER WEEK AT A SOUTH SLOPE SITE
AND A DESERT WASH SITE, YUMA TEST STATION, ARIZONA
DECEMBER 1956



were taken so that the vertical distribution of temperature could be known at all times. Figure 3 shows the average of hourly temperatures at each level for the period of July and August 1956. In many environments the averaging process smooths out many of the important features of the temperature regime, but at Yuma air mass changes are infrequent in summer and the temperature gradients are similar on most days. The average temperature gradients in figure 3 are like the temperature gradients to be expected on most summer days at Yuma.

The outstanding feature of the vertical temperature distribution illustrated is the high temperature of and near the earth's surface at midday. During the two-month period temperatures averaged above 130° F for three hours at the surface, about 30° F higher than at the 2-meter height. On the other hand, in the early morning surface temperatures averaged slightly lower than air temperatures. The highest surface temperature measured during the two-month period was 148° F.

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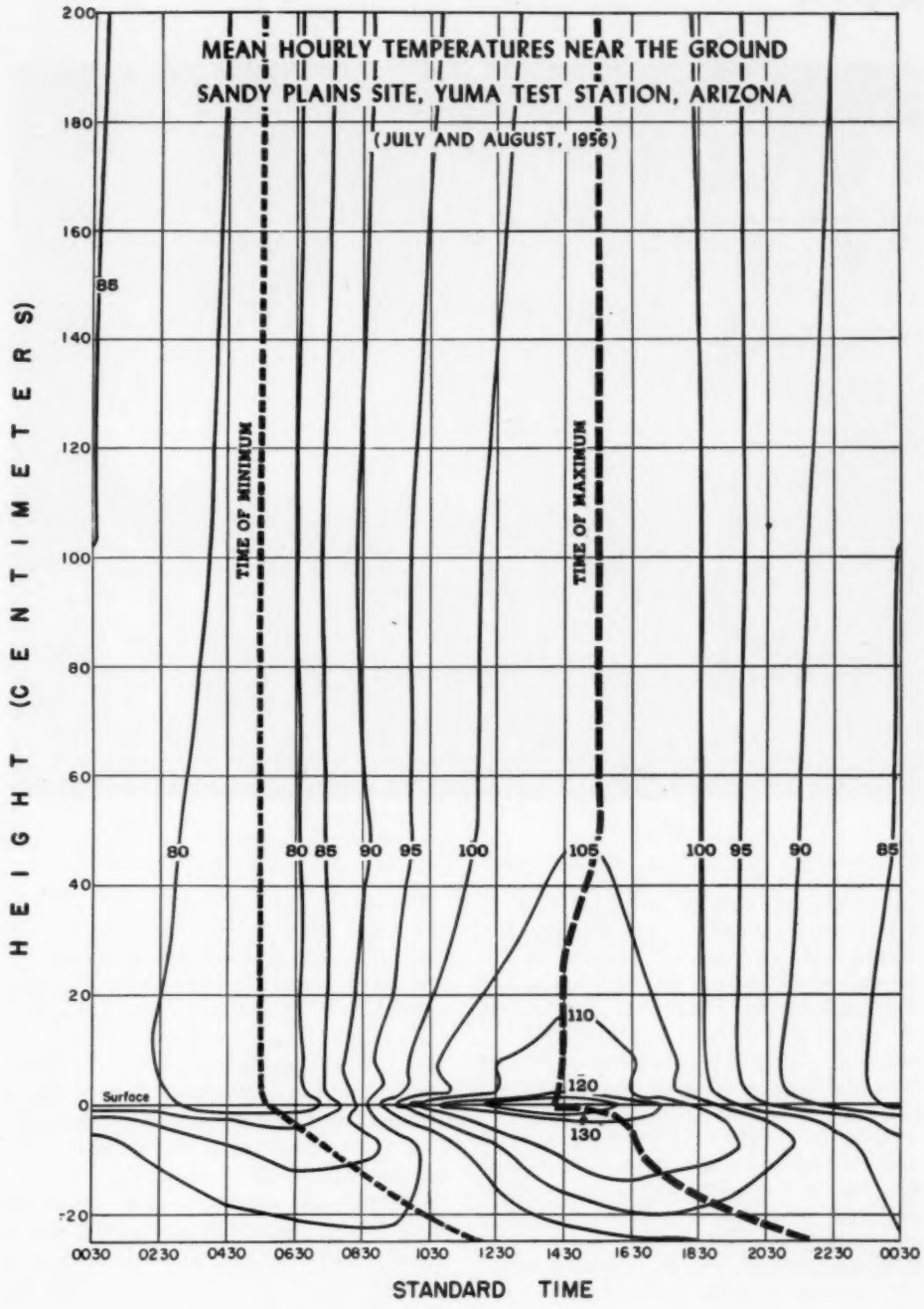
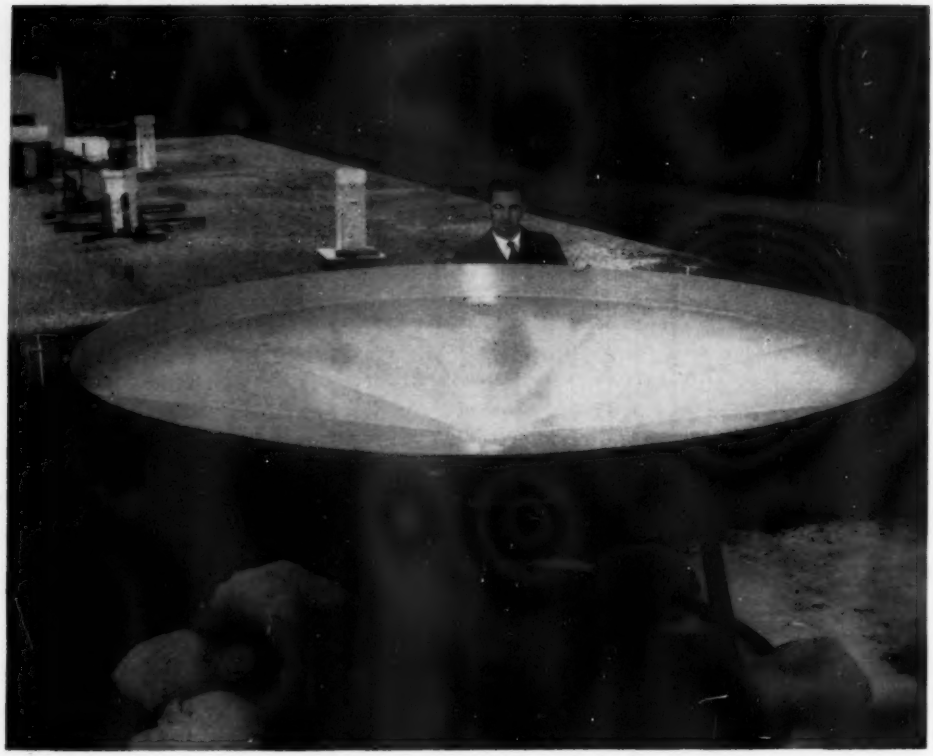
2. Baum, Werner A., "The Temperature at Your Feet," *Weatherwise*, 2—4, August 1949.


MEAN HOURLY TEMPERATURES NEAR THE GROUND
SANDY PLAINS SITE, YUMA TEST STATION, ARIZONA
(JULY AND AUGUST, 1956)
HEIGHT (CENTIMETERS)
STANDARD TIME
TIME OF MINIMUM
TIME OF MAXIMUM
Surface
200
180
160
140
120
100
80
60
40
20
0
-20
0030
0230
0430
0630
0830
1030
1230
1430
1630
1830
2030
2230
0030
88
80
80
85
90
95
100
105
100
95
90
85
110
120
130

AMCOP



A NEW rain collector called AMCOP (a mamouth collector of precipitation) has recently been installed on the roof of the laboratories of Isotopes Incorporated at 123 Woodland Avenue, Westwood, New Jersey. Dr. Alan Walton is shown examining AMCOP which was designed under contract with the Atomic Energy Commission to assist in analyzing radioactive fallout.

In the background can be seen the standard collectors: standard 8-inch gage for rainfall measurement; weighing rain gage; stainless steel pots for measuring monthly rainout of radioactivity; polyethylene collectors for measuring radioactivity in individual rains; and ion exchange columns for the same purpose.

During the last six months the level of radioactive fallout has decreased so markedly that very large rain samples are needed to measure the fallout in individual rains, especially the activity of the rapidly decaying isotopes such as strontium-89 and tungsten-185. This is why AMCOP was built. The diameter of the dish is 10 feet. Thus it has a cross sectional area of 78.5 square feet, collects about 225 times as much water as the standard gage.

AMCOP will also be used to study the effect of gage area on the measured depth of precipitation. Incidentally, the picture does not show the 100 liter collector into which the precipitation runs.

Glossary of Meteorology

A NEW *Glossary of Meteorology* has recently been published by the American Meteorological Society. The volume, which contains 638 pages and some 7247 entries, will largely replace the two similar works in English (British Meteorological Office 1939 and U. S. Weather Bureau 1946). The new volume may be obtained at $12 per copy from the AMS, 45 Beacon Street, Boston 8, Massachusetts.

The aim of the publication is explained by editor Ralph K. Huschke in the preface: "The *Glossary of Meteorology* purports to define every important meteorological term likely to be found in the literature today. It attempts to present definitions that are understandable to the generalist and yet palatable to the specialist; and it intends to be a reference book that satisfies its user in a minimum of his time."

Work on the *Glossary of Meteorology* commenced in 1952 and has been continued over the years under the sponsorship of the following agencies: U. S. Department of Commerce: Weather Bureau; U. S. Air Force: Air Weather Service, MATS and Geophysics Research Directorate, AFCRC, ARDC; U. S. Army: Signal Corps; U. S. Navy: Office of Naval Research.

The initial preparation of the volume commenced under the editorship of James K. McGuire, and the bulk of the task was carried to completion by Ralph E. Huschke. Principal contributors were the late C. E. P. Brooks of Sussex, England, James E. McDonald of the University of Arizona, and Morton G. Wurtele of the University of California. In addition there were 38 subject area contributors. This mass of talent under the supervision of the Executive Office of the AMS has produced a work of immediate and lasting value to the scientific and literary world.

The general philosophy of the *Glossary* has been expressed by the editor: "Any reference book must provide adequate information with a minimum of effort and time required of its user. This glossary has been edited with that principle uppermost in mind. It consists of an alphabetical list, as complete as possible, of words and short phrases as they naturally appear in the literature and conversation of meteorology. Most of these terms are followed immediately by their definitions. Others are followed by references to preferred synonyms." No attempt is made to be "encyclopedic" on any subject, but cross-references in bold type and numerous bibliographical references will assist the reader to a fuller understanding.

The non-professional weather follower will find much of interest and value in the volume. For instance a random opening to page 72 finds the following terms defined: blocking high, blocking oscillator, blood rain, blout (Scottish wind), blowing dust, blowing sand, blowing snow, blowing spray, blowther (same as blout), bloxam (rare), blue band, blue flash, blue-green flame, blue ice, and blue moon.

Readers of *Weatherwise* will be interested in the treatment of two terms often in the news:

Blizzard—A severe weather condition characterized by low temperatures and by strong winds bearing a great amount of snow (mostly fine, dry snow picked up from the ground). The U. S. Weather Bureau specifies, for blizzard, a wind of 32 mph or higher, low temperatures, and sufficient snow in the air to reduce visibility to less than 500 ft; and for severe blizzard, wind speeds exceeding 45 mph, temperatures near or below 10° F, and visibility reduced by snow to near zero.

The name originated in the United States (possibly Virginia) but it has spread to similar winds in other countries. In North America blizzards occur with the northwesterly winds in the rear of depressions in winter. In the Antarctic the name is given to violent fall winds off the ice cap, especially in Adelie Land where an average speed of 107 mph has been recorded over an eight-hour period. In the Savoy (SE France) the cold north wind with snow is termed blizard (see also boulbie). Similar storms in Russian Asia are the buran and purga. In popular usage in the United States and in England, the term is often used for any heavy snowstorm accompanied by strong winds.

(*Continued on page 86*)

A Simple Remote Indicating Wind Instrument

JOHN F. HOLTZ, *1928 Eye St., Washington 6, D. C.*

THIS instrument, which is a complete indicating device, was built at the expense of about $30. The wind speed indicator was manufactured by the Dyno Speed Instrument Co., Lakewood, New Jersey, and retails for $21.95. The cost of the materials for the direction indicator will vary depending on what one may have on hand.

A SELECTED LIST OF MATERIALS

1. A cleaning rod for a .22 cal. rifle
2. A cap from a small jar of paint (model paint)
3. A top from a plastic drinking cup $2\frac{3}{4}$" in diameter
4. A length of aluminum tubing one inch in diameter
5. An aluminum rod $\frac{1}{4}$" in diameter
6. A sheet of copper 3" × 3" and some copper foil
7. Sixty or seventy feet of 4-strand cable (obtain from TV repair house) and an equal length of single strand bell wire
8. Four 3-volt number 14 flashlight bulbs
9. One 6-volt battery (a large battery is needed to overcome the resistance in the line)
10. Two carbon motor brushes and their springs
11. An aluminum cake pan $7\frac{1}{2}$" square by 2" deep

THE TRANSMITTER

For the bearing assembly, the ball bearing handle from the cleaning rod is used. The plastic handle is unscrewed and the bearing is cut off from the rod (fig. 2); if the little ball is misplaced it can be replaced by a "B.B." Drill a hole in the jar cap large enough to accommodate the threaded portion of the bearing assembly and bolt the assembly together, the bearing being nested in-

FIG.1
BEARING ASSEMBLY FOR TRANSMITTER

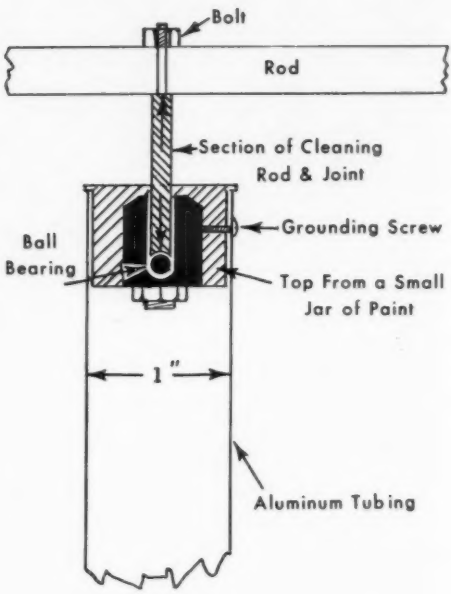
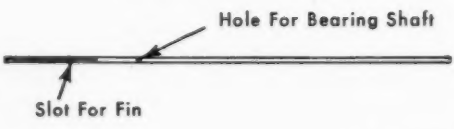


FIG.2

FIG.3
THE VANE

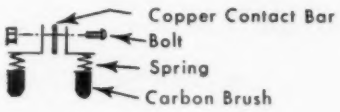


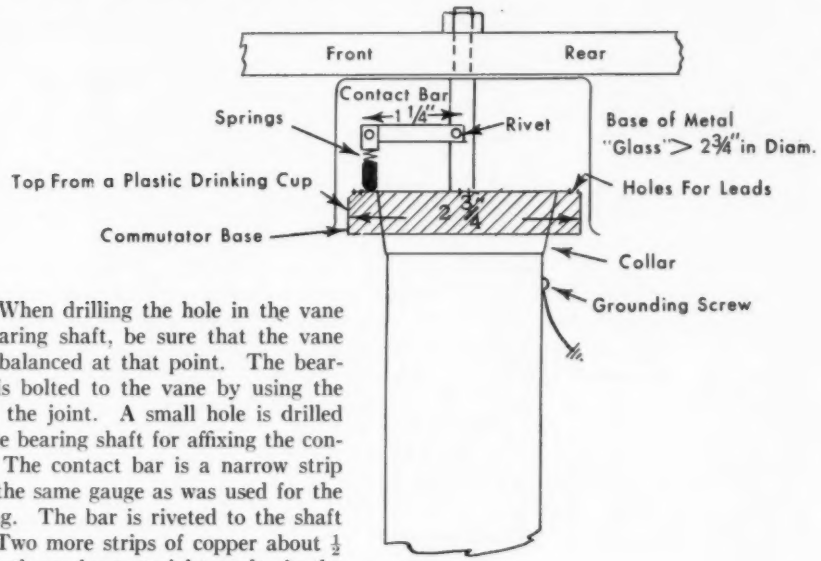
side the cap. This assembly should fit snugly in an end of the aluminum tubing. Drill a hole for a small screw to hold it in place, and also to be used for the ground. Place the ball back into bearing. Cut another length of the cleaning rod at the joint about 2½" long, to be used for the bearing shaft.

For the vane itself, the length of the vane shaft or the size of the copper fin is not too important except for appearance sake. The fin is affixed to the vane shaft by fitting it into a thin slot about 1½" long cut in the shaft (fig. 3). When drilling the hole in the vane for the bearing shaft, be sure that the vane is exactly balanced at that point. The bearing shaft is bolted to the vane by using the threads of the joint. A small hole is drilled through the bearing shaft for affixing the contact bar. The contact bar is a narrow strip of copper the same gauge as was used for the fin 1¼" long. The bar is riveted to the shaft (fig. 4). Two more strips of copper about ½ inch in length are bent at right angles in the middle and a spring and carbon brush are soldered to each.

ELECTRIC CIRCUITS FOR TRANSMITTER FIG.4

CONTACT ASSEMBLY FIG 5





These assemblies are then bolted to the contact bar (fig. 5). The commutator base is made from the top of a plastic drinking cup or its equal. A hole is cut in the center to accommodate the tubing. The base is held in place by a collar of some type and a little glue. Four holes are made equidistant from each other around the edge of the commutator for the leads to the transmitter. Four copper foil contacts of equal size conforming to the shape of the plate are glued to the plate with a quarter of an inch of space between them

COMMUTATOR PLATE FIG.6

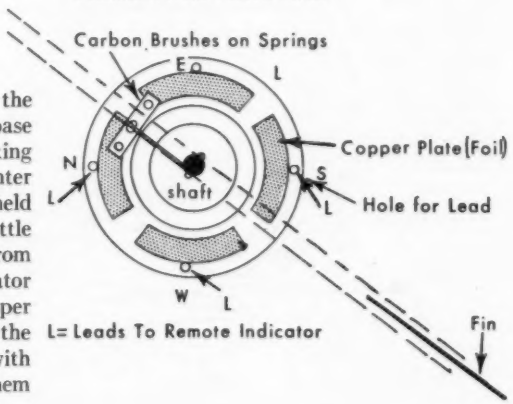


FIG. 7
REMOTE INDICATOR

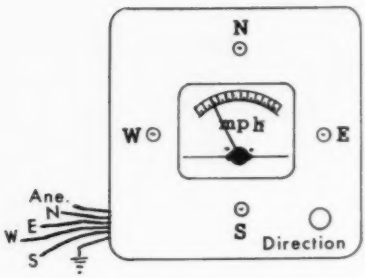
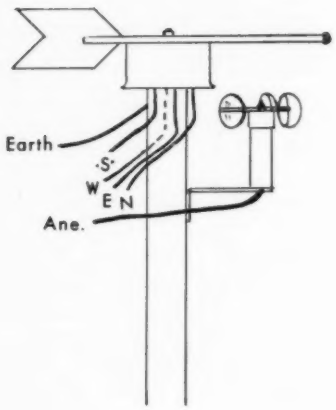


FIG.8
TRANSMITTER



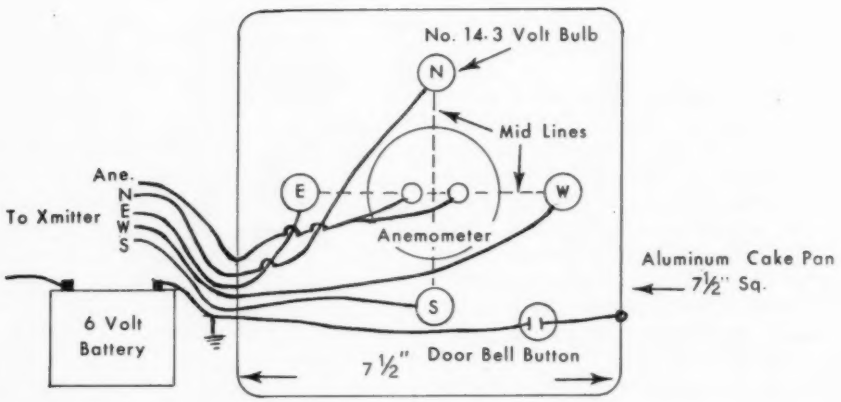
(fig. 6). A lead is soldered to the edge of each contact plate. The bottom of the metal drinking "glass," of a greater diameter than the commutator, is used as a cover for the contact assembly and is affixed to the vane by drilling a hole exactly in the middle large enough to accommodate the small part of the bearing shaft only. The bearing shaft is fitted through the cover, then the vane, and bolted fast. Be sure the contacts are facing toward the front of the vane. The contact pressure on the communtator may be adjusted by compressing or stretching the springs.

The Indicator

An aluminum cake pan is used for the casing. The wind speed indicator is mounted in the center of the pan and four flashlight bulbs are mounted equidistant from it and on the mid-lines of the square pan (fig. 9). If you follow the wiring diagram in figure 9, you should have no trouble completing the indicator. The lead cable from the transmitter is a four-lead cable used for TV installations. One lead bell wire is used for the ground. A six-volt battery must be used with the 3-volt lamp to overcome the resistance afforded by the line and bearing.

You may have some better ideas on some respects of the plans; if so, try them!

FIG.9
WIRING FOR INDICATOR



Early March Storm

(*Continued from page 62*)

built up once more. By 1900 of the 4th the snow level was 10″, at 17″ by 0700 of the 5th, and at 19″ at 1300. It was calculated that 31.3″ of snow had fallen in the entire storm although the maximum depth at any time of 19″ came at the conclusion of the 50-hour storm. Only twice in Nantucket's history have similar totals been compiled: in January 1905 19.1″ fell in 24-hours, and on 27–28 February 1952 in the warm "Cape Cod Blizzard" a total of 20.1″ covered the Island.

The difficulty of making meaningful snowfall depth measurements under conditions of mixed precipitation and when snowfall of varying densities falls is illustrated by reports gathered by *Weatherwise* from cooperative observers in the area of heaviest precipitation. The reports also show various methods employed in attempts to get representative figures. The existing gale conditions, of course, made measurements in exposed locations almost useless.

Salisbury, Md.: 8″ snow, 0.63″ water. Began at 2220/2nd—ended 0153/4th. Very light snow on 5th.

Atlantic City, N. J.: 9.9″ snow, 1.15″ water. Began at 0230/3rd ended 0630/4th. Very light snow on 5th.

Bridgehampton, N. Y.: 21″ snow, 2.27″ water. Temp. on 4th: max. 32°, min. 24°. Wind 35 to 50 mph.

Orient Point, N. Y.: 11″ snowfall, melted 1.00″. "Too heavy drifting to get accurate readings."

Block Island, R. I.: 12″ snowfall, melted 0.87″. "Because the winds reached gusts of 80 mph, there were drifts as high as 14 feet."

Newport, R. I.: About 17″, melted 0.37″. Melted precipitation inaccurate because of high winds drifting light snow."

Warwick, R. I. (Providence Airport): Snowfall of 17.7″ was heaviest ever noted in history of local Weather Bureau from any single storm. Our records date back to 22 Oct. 1904. Water 0.71″.

New Bedford, Mass.: 21″ snowfall, melted 1.75″. "Roads impassable for two days. Drifts 5 to 6 feet high. Winds 35 mph in gusts."

Uxbridge, Mass.: Snowfall 30.3″, melted 3.15″. "Because of severe gusts to 73 mph, snow was measured about 300 yards from base of hill where there was little drifting. Duration of storm: 0925 3rd to 0940 5th. First measurement at 1600/4th. 22 readings averaged 27.4 inches; range 24.4 to 30.0 inches. 2.9 inches received after first measurement. Some packing must have occurred, so 30.3 total is conservative. Water equivalent was determined by cutting sample with 8-inch standard gage and weighing with precipitation scale."

Otis Air Force Base, Falmouth, Mass.: Total snowfall 34″, water equivalent 3.26″. "Based on rate of fall: ½″ per hour for light snow, 1½″ per hour for moderate snow, and 3″ per hour for heavy snow."

East Wareham, Mass.: Snow 18.9″, water 1.38″. "Electric power off for approximately 2 hours of 4th. Considerable number of small limbs broken."

Sandwich, Mass. (entrance to Cape Cod Canal, 65′ el.): Snow 18/22″, water 1.65″. Drifts to 4/5 feet. Much more snow in Sandwich village. Max. wind recorded 74 mph.

Provincetown, Mass.: Snowfall 15″, melted 1.10″. "Damaging winds—utility poles and wires down due to sleet & ice. Town without power for 16 hours."

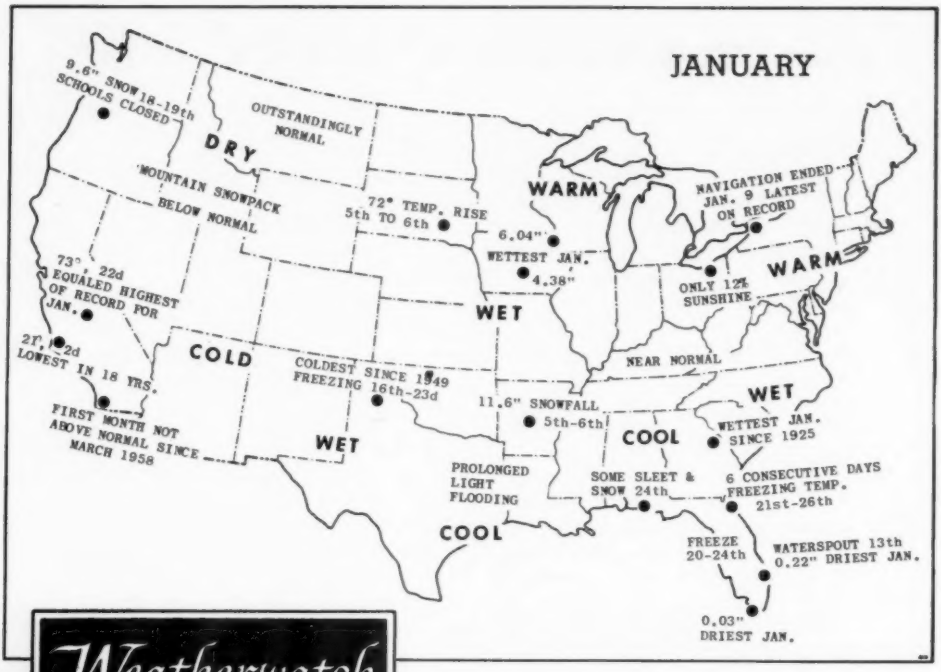
Nantucket, Mass.: Total snowfall 31.3″, melted 3.85″. "March 4th, snow changed to rain and snow at 0145, then to rain from 0350 to 0620, then back to snow rest of storm. All snowfall measurements estimated due to strong winds about 40 with gusts to 55 knots."

The WEATHER PAST / May

1	1898	Manila Bay: Gridley had visibility of 6 miles plus on "misty dawn."
2	1920	Oklahoma tornado in Rogers, Mayes, Cherokee Counties—60 killed.
3	1899	Severe snowstorm Montana 2nd–4th—Havre 33.8″ (24.8″ in 24-hrs.).
4	1761	Large tornado swept Charleston roadstead, damaging large ships.
	1774	May snowstorm from Penna. to New York City south into Virginia—severe frost in North Carolina—fruit killed, wheat damaged.
	1812	Heavy May snowstorm swept Northeast—9″ at Waltham near Boston.
5	1917	Denver's greatest May snowstorm—12″.
6	1876	Chicago: severe local wind storm—$250,000 damage.
	1930	Tornado swept Hill & Ellis counties just south of Dallas—41 dead.
7	1840	Great Natchez Tornado—city in ruins—300 killed or drowned.
8	1803	Famous May snowstorm spread 6″ from southern Indiana to southern New England—ruined Phila's shade trees—sleighing in Mass.
9	1926	Latest opening of navigation at Buffalo, N. Y.
	1927	Tornadoes swept Randolf Co., Ark., & Popular Bluff, Mo.—86 dead.
10	1905	Deadly tornado at Snyder, Oklahoma—87 killed.
	1945	Late New England snow—26″ N. H., 15″ Me. & Vt., 10″ Mass., 4″ Ct.
11	1934	Great Dust Bowl storm darkened skies from Okla. to Atlantic Coast.
	1953	Waco Tornado killed 114 at Texas city—$200 million damage.
12		
13	1930	Only authentic U. S. human death by hail—36 m. NW Lubbock, Texas.
14	1896	Climax, Colo.: −10°—lowest ever in U. S. for May.
15	1834	Great May snowstorm New York & New England—24″ Newbury, Vt.
16	1917	Marquette, Michigan, latest opening of navigation.
17	1794	"Uncommon frost" in southern New England destroyed early crops.
18	1825	Tornado crossed all Ohio—wiped out Burlington, 23 m. NE Columbus.
	1894	Chicago: severe storm rain and snow—9 vessels total wrecks.
19	1780	The Dark Day—famous in New Eng. tradition—nighttime at noon.
20	1892	Snow with high winds western New Eng.—Strafford, Vt. 10″.
	1957	Tornado ended 71 mile track in Kansas City suburb—48 dead.
21	1896	Salton, Calif.: 124°—highest ever in U. S. for May.
22		
23	1882	Late May snowstorm in Iowa: 4″–6″ white blanket in east.
24	1877	Inland snowstorm New Jersey to New Eng.—4″ Berkshire Co., Mass.
25	1837	Vicksburg, Miss.: series of severe frosts "which was extraordinary."
	1955	Tornado destroyed Udall, Kansas (25 m. SE Wichita)—80 dead.
26	1917	Longest modern tornado—Missouri, Illinois, Indiana—293 miles in 7⅓ hours—struck Mattoon & Charleston, Ill.—70 killed.
27	1917	Tornado outbreak resumed in Tenn. & Ky.—70 killed.
28	1809	Cincinnati: Three tornadoes crossed town and moved up Ohio Valley.
29	1877	Yuma, Ariz.: severe sand storm raged for two days.
	1951	Great hail storm Wallace to Kearny Cos., Kansas—$6 m. damage.
30	1879	Many tornado outbreaks in NE Kansas—Irving wiped out—60 dead.
31	1889	Johnstown Flood in Pa.—rains topped earth dam—2,100 dead.

The WEATHER PAST / June

1	1812	New Haven: latest blossoming of apple trees (1794–1960).
	1843	Snow fell at Cleveland, Buffalo, Rochester—whitened ground.
	1903	Tornado at Gainesville, Georgia—killed 98.
2	1889	Great flood on Potomac—took out span of Long Bridge at Wash.
3	1756	Benjamin Franklin completed his *Physical and Meteorological Observations, conjectures, and suppositions.*
	1860	Great Iowa-Illinois Tornado—ended in Lake Michigan—175 killed—named Comanche Tornado for destruction of town on Miss. River.
4	1825	Early hurricane from Cuba to New England—great shipping loss on coast—much damage Charleston on 3rd & New York Harbor on 4th.
5	1816	Early heat wave: Salem 92°—dropped 49° next 24-hours.
	1859	Great June frost Iowa to New Eng.—25° west N. Y.; 2″ snow Ohio.
	1925	Washington, D. C.: earliest 100° of record.
6	1944	D-Day in Normandy: lowest June barometer of record on 5th—variable cloudiness followed on 6th: (0400 4/10–6/10 clouds at 3000′—0545 beachhead clear, 6/10 inland—overcast middle clouds later).
7	1816	Famous June snow: Danville, Vt. snow/sleet drifted to 20″—all highlands snow covered—severe frost: Waltham 33°, New Haven 35°.
8	1816	Flights of snow as far south as Salem and Waltham in Boston area.
	1885	Fargo, N. D.—killing frost—none since in June.
9	1953	Worcester County Tornado in Mass.—90 killed—worst ever in East.
10	1752	B. Franklin narrowly missed electrocution flying kite in storm.
	1816	Portland, Maine—snow flurries—34°—ice in streets.
11	1842	Northern New England: heavy June snow—11″ at Berlin, N. H.
	1877	Los Angeles: 112° capped 4-day, 100° plus heat wave.
12		
13	1889	Laramie, Wyo. snow fell all day—about 24″ near Rawlings.
	1907	Tamarack, Calif.: +2°—lowest ever for U. S. in June.
14	1922	Tropical storm hit lower Rio Grande Valley—severe floods on 15th.
15	1662	Drought at Salem—Prayer for rain: "The Lord gave a speedy answer."
16	1794	Mansfield, Mass.: frost repeated visitation of May 17th.
17	1775	Battle for Breed's Hill, nearby Bunker Hill—"The day was hot."
	1882	Great Grinell, Iowa, Tornado—60 killed—track 200 m.—$1 million.
18		
19	1835	Tornado New Brunswick, N. J.—5 killed—studied by Redfield & Espy.
20	1762	G. Washington: "Have had one of the severest droughts ever known."
	1884	Kansas City: Great flood reached peak of 37 feet, 16 above flood.
21	1953	Severe hail Wichita vicinity, Kansas—$9 million damage.
22	1947	Holt, Missouri—12″ rain fell in 42 minutes for U. S. record.
23	1902	Volcano Springs, Calif.: 129°—highest ever in U. S. for June.
	1944	Tornado family Ohio to Maryland—killed 150, mainly in W. Va.
24	1816	Three 90° days followed early June cold—99° on 23d at Waltham.
25	1749	Massachusetts: "A general fast on ye account of ye drought."
26	1888	New York City: Record 14 consecutive days with 80° plus ended.
27		
28	1924	Tornado swept Lorain and Sandusky, Ohio—73 dead.
29	1957	Hurricane and storm tide hit Cameron area in Louisiana—430 lost.
30	1886	Destructive hurricane struck Apalachicola-Tallahassee area.



Weatherwatch

Data by Office of Climatology, USWB.

Winter Makes a Late Start

DAVID M. LUDLUM

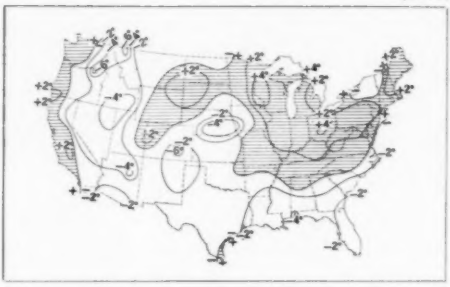
As the winter season moved into January, the pattern which had developed in late November with mild maritime air from the Pacific Ocean flooding across most of North America received a momentary check. A marked ridge built up along the Pacific Coast States at the turn of the year, to shut off the westerly flow and introduce a northeasterly air stream to the West Coast. A small Plateau high over British Columbia and Alberta provided the mechanism to pour cold air into central and southern California with freezing temperatures except along the immediate coastal strip from Los Angeles southward. A low of 21° was registered at Santa Maria on the central coast.

The cold air also flowed along the crest of the Rockies and then dropped southeastward into Texas and the Gulf States to provide a cold start for the New Year in the Southland. The cold air stream, pushing in from the West, helped to intensify a low moving across New England on the 2–3rd into a severe storm with whole gale winds.

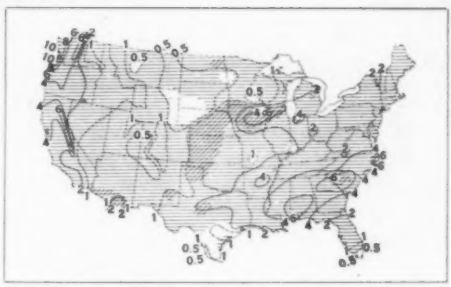
At the conclusion of the first week the streamlines of air flow flattened out and once again Pacific air pushed eastward to bring a marked mild spell to most of the Plains and Midwest. Chinook winds descended from the Rockies to raise the mercury to high levels. Rapid City, South Dakota, had 56° and Kansas City 65° on the 11th. In the Midwest and East a strong southwesterly flow, preceding a slow-moving trough, pumped warm air northward to the Lower Lakes and St. Lawrence Valley for a mid-winter thaw. From Missouri to Ohio temperatures for the week 10–17 January were 12 degrees above normal and upwards of 6 degrees-plus over a wide area.

A change in the upper-air pattern was signaled by the appearance of stormy conditions in the Gulf of Alaska, from whence two disturbances moved inland over California on the 11th and 14th. Both traveled southeastward to New Mexico before recurving northeastward headed for the Lower Lakes. The extreme southern trajectory of these lows pulled cold air southward from Canada into the Plains and Mississippi Valley. The air from the North appeared to be modified polar and not true January arctic stuff, since temperatures (except at high elevations in Idaho and western Montana) did not sink to extreme mid-winter levels.

After the passage of the second low eastward on the 17–18th, the pressure systems took on a mid-



Departure of Average Temperature from normal in degrees Fahrenheit. USWB chart.



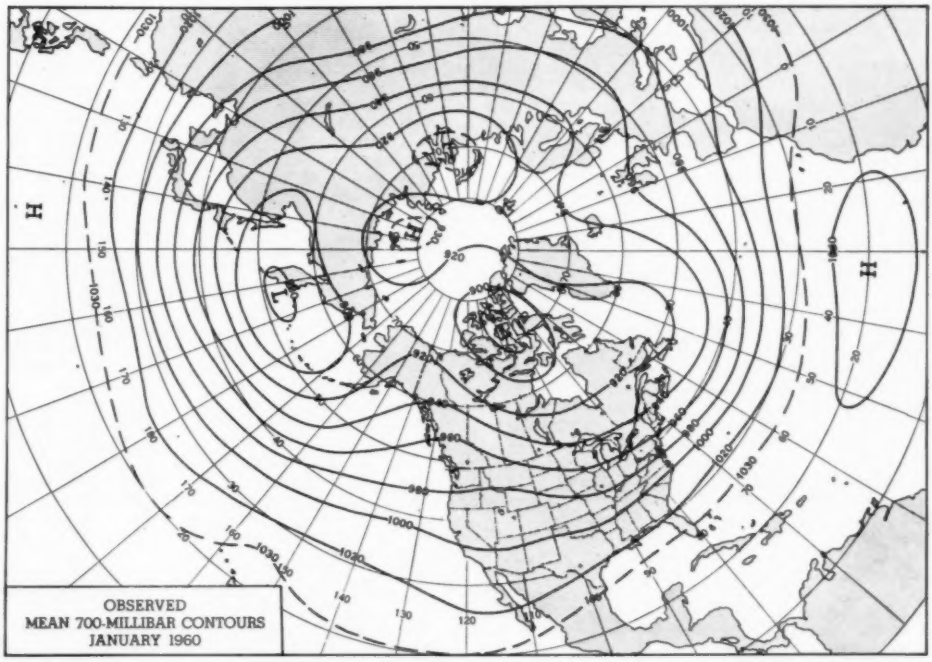
Total Precipitation in inches USWB chart.

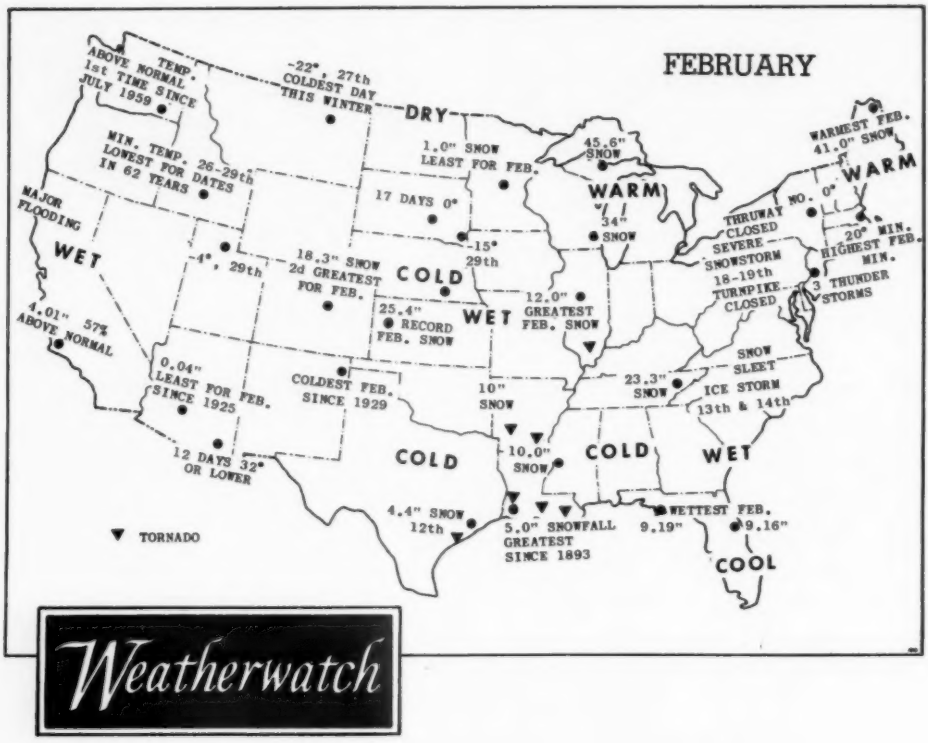
winter static stance: a vast ridge of high pressure built southward over the Plateau and along the crest of the Rockies and held firm, while a trough of low pressure lingered over the Lower Lakes and New England. From the 17th to the 23rd the weather map wore much the same face with a great sweep of northwesterly winds from the western ridge carrying cold air into the heartland of the South. The mercury fell to the low 20's along the Middle Gulf Coast and below the freezing mark in the interior of southern Florida. Frost formed on several successive nights in south-central Florida, to chill agricultural prospects and vacationers alike. Only the Lake region, New England, and eastern Canada escaped this week-long stretch of winter-like conditions as an easterly circulation, swinging northward and westward around an almost stationary Atlantic low, brought maritime control to southeastern Canada and northeastern United States.

The final seven days of January formed a distinctive period with a return to the mild conditions in the central valleys which had reigned during the second week. The high pressure forming the core

(*Continued on page 82*)

The upper-air map below shows the pattern of air flow for January at about 10,000 feet, on which the average weather largely depends. The contours lines represent the mean height of the 700 mb. pressure level. Figures are in tens of feet: 1020 = 10,200 ft., 980 = 9,800 ft., etc. Chart by Extended Forecast Section, USWB.





Weatherwatch

Unlike the preceding month, February provided some interesting meteorological situations. Though there were several fluctuations in the weather control during January, the departures from normal of the weather elements cancelled each other, and the averages ran surprisingly close to normal in diverse parts of the country. February exhibited only one major change in weather control, and this conveniently came halfway through on February 16th when air from the Arctic regions began to stream across the Canadian border, routing the spell of mild mid-winter conditions which had become established at the start of the last week in January.

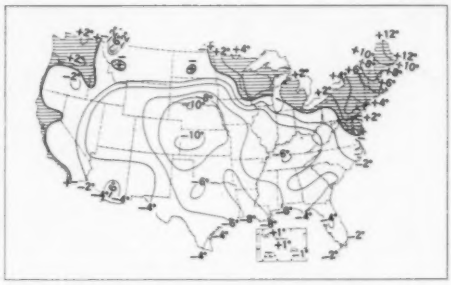
At Great Falls, Montana, crossroads for international air masses as well as of air lines, the temperature averaged above normal each day of February from the 1st through the 16th; thereafter, all were either exactly normal or below, with the concluding week being much below. It may be recalled that severe winter commenced in Montana in mid-November with record low readings for so-early-in-the-season, and now the season was ending on a similar note, setting marks in the closing days of February for so-late-in-the-season low readings.

The first half of February was marked by cyclonic activity over the western half of the Nation. From a deep low in the Gulf of Alaska frontal disturbances moved from the North Pacific across British Columbia and the Northwest States. Pressure was also relatively low over western Canada. Several Alberta type lows formed on the pressure troughs moving from the Pacific, and there was cyclonic regeneration in the Northern Rockies as well.

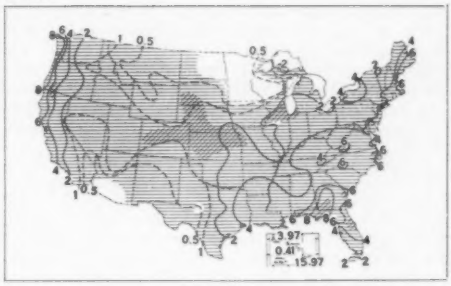
One of these lows developed a most unusual situation when a deep trough passed inland on the 8th and reorganized in Wyoming. In its passage southeastward to the Kansas-Oklahoma border it deepened very rapidly to set all-time marks in the area for low barometric pressure. Wichita, Kansas, reported 28.71″, the lowest since the establishment of the Weather Bureau there in 1888. Tulsa, Oklahoma, had 29.74″ at about noon of the 9th, and later on Springfield, Missouri, had 28.77″. Stations from Denver southeastward as far as Dallas-Ft. Worth, and northeastward to Springfield, Illinois, generally reported their lowest all-time readings, including Kansas City with records back to 1888 and St. Louis with records to 1871 where the low figure was just equaled.

Each depression in the first part of the month was followed by an influx of mild Pacific Ocean air. At Great Falls the first 16 days averaged 11.5 degrees above normal, with a narrow total range from 50° to 19°. But late on the afternoon of the 16th Arctic air began to take charge and did not relax its grip until well into March. From the 17th to 29th the daily depression of the mercury at Great Falls averaged 13.5°, with the absolute range from 38° to −20°. From the 25th to the 29th it was severely cold.

The transition period from Pacific to Arctic control came with the passage of two Alberta lows



Departure of Average Temperature from normal in degrees Fahrenheit. USWB chart.

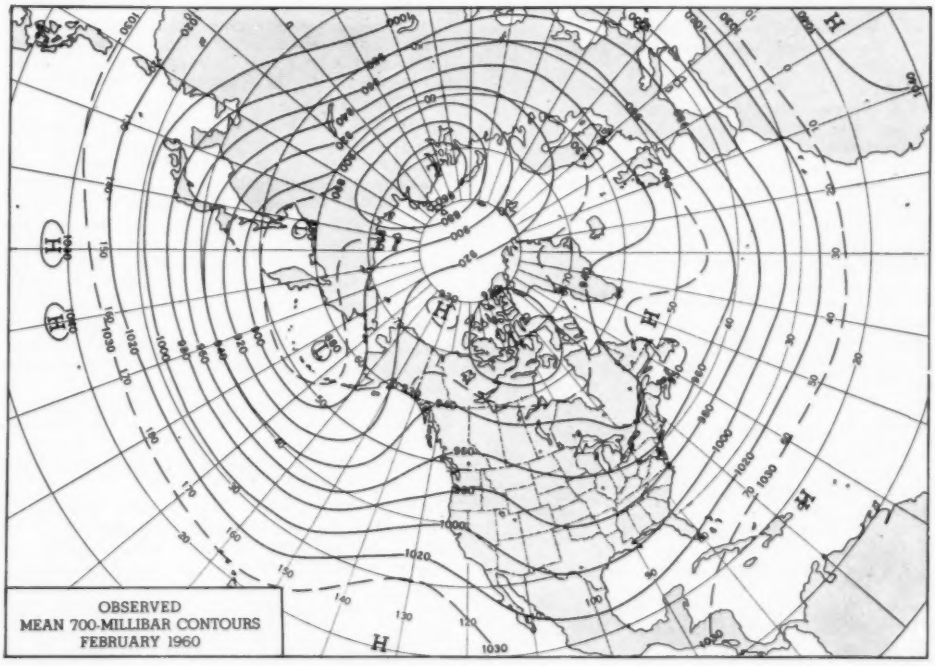


Total Precipitation in inches USWB chart.

eastward on the 13–16th and 15–18th. Close on the heels of the second low followed a large Canadian anticyclone of great strength (1048 mb/30.95″) over Great Bear Lake on the 17th. This core of cold air flooded all the central valleys and penetrated deep into the Southland—only the immediate Lakes region and the Northeast were shielded. Thereafter, an active storm track led depressions southeastward from the Rockies to the Texas Panhandle where they turned northeastward toward the Lakes, all-the-while pulling cold air far southward. A pronounced tendency appeared for the formation of secondaries, either in the West Gulf close to the Texas coast or in the Carolinas. The circulation around these secondaries usually became the major influence, spreading snow across the Middle South and bringing more cold air deeper into the interior of the South.

The main pressure feature of the second half of the month, a broad trough of low pressure, developed over central and southern Canada and the northern United States after the anticyclone of the 17th passed southeastward. It was remarkable for its width, stretching at times from Quebec to the Rockies. Along its western flank air flow came directly from the north carrying a deep current of Arctic air southward into the Plateau and Plains. The track of the jet stream lay far south of its normal position with a mean track over Texas and the Gulf States where it swept depressions rapidly eastward and encouraged the development of secondaries.

The axis of the broad central trough in the latter days of the month lay just west of Lake Superior. Wind flow into the Lower Lakes region and the Northeast, coming from the southwest, in-



duced several lows to move directly across Lakes Erie and Ontario which put the Northeast in their warm sectors. The warmer-than-normal area shrank considerably during the last week of February, but from coastal New Jersey northward the last week still averaged warmer than normal. Caribou, Maine, for the final week had a plus departure of 12 degrees; at the same time Goodland, Kansas, ran a remarkable 30 degrees below normal.

To further illustrate the vagaries of February, Caribou averaged 12 degrees above normal for the entire month—Goodland, despite a warm first ten days, had a minus departure of 10 degrees. A vast area from Nebraska southeastward to the western and middle Gulf coasts ran more than 6 degrees below. At many points it was the coldest February since the bitter winter of 1935–36, and the snowiest of all-time.

FEBRUARY NOTES

CARIBOU, ME.: February was a cloudy, wet, mild month. A new record for monthly average temperature was established (22.9° or + 13.1° departure), and the snowfall record for the month was equalled (41″).

PROVIDENCE, R. I.: This was the 6th warmest and 2nd wettest February in 56 years. Precipitation totalled nearly twice normal and was almost entirely in the form of rain, associated with the passage of five major storm systems (on the 6th, 11th, 14th, 18–19th, and 25–26th). High winds accompanied each of these storms, with gusts of 40 mph or greater on 11 days. Only six other Februaries had lesser amounts of snowfall.

WASHINGTON, D. C.: First measurable snow of season fell on 13–14th—6.2″. Maximum for month, 68° on 10th, equaled date record. Lowest for month only 20°.

LYNCHBURG, VA.: Snowfall of 12.8″ on the 13–14th was heaviest since Feb. 25, 1934 when 14.8″ were recorded.

ROANOKE, VA.: Several precipitation records were broken. Monthly snowfall of 27.6″ exceeded all previous months back to 1901. Maximum 24-hour snowfall of 15.7″ on 13–14th exceeded all records back to 1901. Total precipitation exceeded all February records back to 1912. Wind gusts reached 78 mph on February 18.

RALEIGH, N. C.: A notable feature of February 1960 was the snow, sleet, and ice storm of the 13th. Considerable damage was done to trees, power lines, and telephone lines, many trees being broken or uprooted by the heavy accumulation of ice and subsequently falling across utility lines.

KNOXVILLE, TENN.: The 23.3″ of snowfall is the greatest monthly total since February 1895 when the total was 25.7″. On the 13–14th 18.8″ fell.

VICKSBURG, MISS.: The month was quite cold and stockmen were running short of feed. One of the lowest barometer readings of record, 29.21″, occurred on the 10th and was followed by a 10-inch snow on the 12–13th. This snow was only 0.1″ below our record depth which occurred in 1919.

LAKE CHARLES, LA.: The average temperature of 48.0° was the coldest for February since 1947. The snowfall of 5 inches on the 12–13th was the greatest for any month of record dating back to 1893.

HOUSTON, TEX.: The coldest February since 1936. Three inches of snow on Lincoln's Birthday set a new record for February since the historic snowfall of 20″ on Feb. 14–15, 1895.

LAKELAND, FLA.: Scattered frost, mostly light, on 15th and 20th, with very heavy frost on 15th in outlying areas which caused slight damage to unprotected tender vegetables and ornamentals. Soil moisture was generally adequate; however, rather cool temperatures most of month slowed growth.

ROCHESTER, N. Y.: This month's snowfall (58.3″) exceeds all other months in the Rochester record except February 1958 which had a total of 64.8″. Snowfall this winter now totals 128″, a new record for this point of the winter season. The next greatest was 120.9″ reached at the end of February 1958.

BUFFALO, N. Y.: It was mild until midmonth. A series of major storms then occurred bringing the snowfall for the month to near record level. The precipitation of 5.80″ broke the old record of 5.74″ set in 1910. Total snowfall amounted to 49.5″, but was exceeded by 54.2″ in 1958. Many highways were closed for protracted periods due to heavy snow. The storm of the 18–20th closed the New York State Thruway for 19 hours, stranding hundreds of vehicles and over 1,000 travellers. Six deaths were reported. More than 1,000 plows worked continuously to combat drifting.

ROCKFORD, ILL.: The outstanding feature of this month was the unusually heavy snowfall. The monthly total was exceeded only in one other February in the past 55 years. The snowstorm of February 9–10th, which deposited a total of 11.4″, was accompanied by high gusts to 40 mph, resulting in drifts as high as 10 feet and near isolation of the city for a period of nearly 24 hours.

SAINT CLOUD, MINN.: This was another very pleasant winter month with an almost complete absence of unfavorable or severe weather. Total snowfall of 1.0″ for this month is the smallest monthly snowfall for the period of record dating from 1939.

SAULT STE. MARIE, MICH.: All months, Dec.-Jan.-Feb., averaged above normal, but there have been seven warmer winters than the past one. The above normal winter produced only one-half its normal ice thickness at the close of February.

DES MOINES, IOWA: Snow covered the ground during the entire month. The cover varied from 2 to 13 inches. The total fall of 18.5″ has been exceeded in only three previous years. The highest temperature of 44° was the lowest maximum extreme since 1929.

MILWAUKEE, WIS.: Like the two preceding snowy months, February 1960 with 34″ was the second snowiest February since snowfall records began in 1884. The storm with north and northeast gales on the 10th deposited 16.7″ in 24 hours, the 2nd heaviest 24-hour amount for a February. A gust of wind on the 10th reached 61 mph. Deepest snow cover was 22″ on 25–26th.

GREEN BAY, WIS.: Weather was nice also in February as in both December and January. All agree this has been the best winter so far in memory. What made it so pleasant is the lack of severe storms, not much snow, very few zero days, and an unusually small change in temperature from day to day. No one remembers the Fox River remaining open thru January until February 12th.

MARQUETTE, MICH.: The snowfall of 45.6″ was the second heaviest total snowfall for February, being exceeded only by the 54.3″ which fell in 1890. For all months of record, only five times was the total snowfall in any month greater than in February 1960.

TOPEKA, KANS.: Unusually cold stormy month with frequent heavy snows but no bad drifting. Third largest February snowfall since 1888 and most February snowfall since 1901. Ten inches depth evening of 23rd deepest snow on ground since December 1942. Lowest barometric pressure of record, 28.82″ on 9th, reduced to sea level. Muddy feedlots and country roads forepart of month and intense cold with deep snow latter part very hard on livestock and made their care and feeding difficult. Outside construction work greatly curtailed or halted entirely by rigorous weather of the month.

DENVER, COLO.: This was the second snowiest and the eighth coldest Feb. of record. The total snowfall through Feb. was 61.7″ as compared to a normal of 34.2″. New minimum temperatures for the date for the airport were set on the 24th thru 29th. New low maximum temperatures for the date for the airport were set on the 23rd, 24th, and 26–29th. The seven days of minimum temperature of zero or lower was exceeded in duration only 4 times. The sea level pressure of 28.83″ on the 9th was the lowest ever recorded in Denver.

HELENA, MONT.: A very mild and pleasant winter month for the first three weeks, but the last week was very cold. The −18.3° minimum observed on the 28th was the coldest for that date in 80 years of record. There were both fewer clouds and more sunshine than usual in February.

YAKIMA, WASH.: February temperatures were normal or above normal until an invasion of Arctic air dropped temperatures to much below normal the last five days of the month. New daily records for low temperatures were set on the last four days of the month. Cherries, peach, and apricot buds sustained only slight damage except possibly in the real cold locations. Lowest: +7° on 27th.

SACRAMENTO, CALIF.: The rainy pattern which began on December 23rd continued through January and over the first nine days of February. Rainfall during that period amounted to 7.31″ and exceeded the normal rainfall for the 78-day period by more than 50%. There was no rain after the 9th except a negligible amount on the 13th. Winds on the 1st reached a speed of 58 mph in gusts during a storm. Another gust of 48 mph came on the 8th.

LONG BEACH, CALIF.: No *unusual* weather of note occurred during February.

SAN DIEGO, CALIF.: Temperature during the first half of February was above normal, but the monthly average was about normal. Max: 74°, min: 42°.

CANADIAN HIGHLIGHTS

February 1960 was an unseasonably mild month in Canada. It was the warmest February on record at several stations in the Maritime Provinces and the Quebec-Labrador Peninsula. Sydney, N. S., with a mean temperature of 29 was the warmest February in 87 years and a mean temperature of 32° at Halifax was the second warmest in 91 years of record. The greatest departures from normal occurred further north on the mainland where Indian House Lake was 27° above normal.

With a mean temperature of 43° Victoria, B. C., was the warmest location in Canada over the month as a whole, while 60° at Nanaimo, B. C., was the extreme high reading in the country. On the other hand, Eureka, N.W.T., was the coldest in the nation with a mean temperature of −31°, an extreme low of −52° and a total of heating degree days below 65° F of 2884.

Snowfall was exceptionally heavy over a broad band from southern Quebec northward into the Arctic. Quebec City reported 59 inches of snow, the greatest in a February since 1939, while 48 inches at Ottawa was the greatest snowfall reported in February in 71 years of record, as well as being the all-time maximum fall for any month. By the end of February, snowfall had amounted to 152″ for the season at Quebec City. Considerable rain at Quebec gave a total precipitation value of 7.32, an all time record for February precipitation.

The most notable snowstorm in February in eastern Canada occurred along the south shore of Nova Scotia where Halifax reported 30″ of snow on February 2nd–3rd. Several stations reported precipitation day snowfall totals in excess of 20″, establishing new records for the area. On the night of February 25th–26th, a heavy snowstorm with severe drifting struck southern Ontario and in a broad band from Windsor through Toronto it was the heaviest snowfall in 24-hours since December 1944. With milder temperatures than normal, considerable rain fell on Newfoundland instead of snow, and Gander reported 3.33″ of rainfall, the greatest on record for February.

Pressures were exceedingly high in the Canadian Arctic during the month and the northern Arctic Islands averaged more than ten millibars above normal. It was a windy month all across the country with the following new February hourly wind speeds established:

Vancouver	45 mph with gusts to 70 on the 20th and considerable damage re-reported.
Regina	49 mph with gusts to 69 on the 7th.
Montreal	windiest February on record.
Halifax	48 mph on the 19th.

On the West Coast at Vancouver and Victoria it was the sunniest February in two decades, while on the East Coast Halifax experienced an unusually dull month with 12 completely sunless days.

ALASKAN NOTES

ANCHORAGE: The month of February 1960 was a pleasant one. The mean temperature was 4.1° above normal, and the coldest temperature observed during the entire month was 4° above zero. Only 8.5″ of snow fell on the area, and the total precipitation was only three-fourths of normal. There were no damaging winds, but on 8 occasions aircraft operations were delayed by fog.

FAIRBANKS: The month was warmer and drier than normal, with only one week of below normal temperatures. Max: 31°, min: −29°. Snowfall: 6.5″.

BARROW: The maximum of 32° on the 28th was the highest ever recorded in February, previous high 31° in 1923. Continuously below zero 1st to 16th; warm spell 17th to 29th. Only 1.3″ snowfall—cover 13″ all month.

CORDOVA: Average temperatures this month were unusually mild and station pressure remained consistently high during the latter part of the month, bringing very agreeable weather. Max: 47°, min: 11°. Snowfall: 22.9″.

HAWAIIAN NOTES

HONOLULU: Smoky conditions caused by the volcanic activity on the Island of Hawaii continued to restrict visibility at this station from 1.5 to 5 miles through the 4th. A new February record low temperature of 56° was established. Max: 84° on 6, 7, 29th.

HILO: The lowest minimum temperature of the month, 55°, equaled the lowest of record for any month.

LIHUE: This February was a month of temperature extremes. The highest of 86° exceeded and the lowest of 53° equaled previous February extremes. Larger than usual daily departures from normal temperature and daily ranges were also noted. Over 80% of the monthly rainfall of 4.14″ occurred within two 24-hour periods, and one-third fell in one 30-minute period on the 19th (1.80″).

PUERTO RICO NOTES

SAN JUAN: February 1960 was the second warmest February of record. New daily temperature records were established on 1, 18, and 23rd. This is the first month since April 1959 with above normal rainfall. Total of 3.91″ was plus 1.17″. New one-hour and two-hour rainfall records were established on the 10th, replacing those set in 1918 (2.01″ in one hour, 2.76″ in two hours on Feb. 10, 1960). Local flooding disrupted traffic and caused slight damage on 10th in Santurce section of Metropolitan area.

January (*Continued from page 77*)

of the vast western ridge drifted southeastward to the Gulf Coast and Southeastern States where it still dallied on the 24–26th. Meantime, depressions from the Pacific commenced to enter British Columbia and Washington, moving east or southeastward over the northern Rocky Mountains as the westerly air flow reasserted its steering influence. As the month closed, a secondary disturbance formed in Texas and then moved eastward along the Gulf Coast and into the Atlantic, bringing a wet, rainy period to the Southeast as a departing gesture from a cooler-than-normal January there. This latest storm track presaged much interesting weather to come in February.

Atmospheric pressure over the United States during January averaged very close to normal, and this accounts for the "normality" of the weather and the lack of spectacular events. Upper-air contour levels, also, ran close to normal. There was a small ridge on the mean pressure maps over the Pacific States and British Columbia, and then a long wave pattern eastward to a trough running southward from Newfoundland into the central Atlantic. There were no troughs over the continental United States to bring clashing air masses into play. The outstanding departure was a blocking anticyclone over Greenland where pressure both at the surface and aloft ran much above normal, in northeastern Canada as much as 8 mb/.25″ above the normal for January.

The blocking anticyclone played a key role in the January temperature regime. It was an outstanding mild winter in eastern Canada from the Arctic southward to New England. Goose Bay, Labrador, had a mean 10 degrees above normal. The Canadian warm sector bulged southwestward to include the upper Mississippi Valley, the Lakes region, Ohio Valley, and most of the Northeast. In Florida, along the Gulf Coast, and in the Southeast, January 1960 was definitely a below normal month to add to the recent string of unpleasant winter months in that winter vacationland. The southern and central Plains, along with the Plateau area, averaged below normal as cold air was drawn southward during the middle two weeks of the month in the wake of lows moving along the Mexican Border States. But the Pacific Coast, following the trend of recent months, ran comfortably above normal.

Precipitation in the United States and Canada figured close to or below normal in all areas with two major exceptions, and each of these bands of heavy rainfall reflected the prevailing storm tracks of the month. From the Mexican Border northeastward a long ribbon of heavy precipitation, much in the form of snow, paralleled the main January storm track. In parts of Iowa and Illinois it was the wettest January of record. Little Rock, Arkansas, had its second heaviest 24-hour snowfall. The wet band continued across the Lower Lakes and northeastward up the St. Lawrence Valley to Newfoundland where St. John's had an impressive total snowfall of 63.8″. A second strip of heavy precipitation developed late in the month from the Gulf Coast of Alabama northeastward to southeastern Virginia, flanking the developing storm track. Elsewhere it was generally a dry month with the northern Plains and interior areas of Canada showing very light precipitation. And in extreme southeastern Florida January was almost rainless.

JANUARY NOTES

BOSTON: The mercury failed to go below 9°, and on only 4 days did it go below 20°. No snowstorm yielded more than 4″. Snow fell on 16 days for a total of 10.2″, or 1.8″ below normal. On 3rd wind at 62 mph during heavy rainfall.

BURLINGTON, VT.: The month was a little colder and drier than usual, but on the whole rather pleasant due to considerably more sunshine and much less wind than is customary for January. No well-developed January thaw took place.

CONCORD, N. H.: The January weather was normal; no deviation from the established average value of any element.

WASHINGTON, D. C.: Only a trace of snow, equals record. Lowest temperature only 20°.

CAPE HATTERAS, N. C.: Precipitation was much above normal during January with 67% of the total falling on the last five days: 3.31″ in 24-hrs on 30–31st. Lowest temperature 24°.

JACKSONVILLE, FLA.: The six consecutive days of below freezing temperature from the 21st through the 26th was the first time this has occurred in January since the records began in 1872.

WEST PALM BEACH, FLA.: A waterspout was observed 5 miles east of the airport on the 13th. The driest January on record, only 0.22″ which fell on the 30th.

MIAMI, FLA.: On 22–24 January frost and freezing temperatures were quite general, extending nearly to Biscayne Bay. There were several reports of readings as low as 26°. Damage to tender truck and ornamentals was extensive.

KEY WEST, FLA.: Driest January of record (0.03″) on 16th and 30th. Previous driest 0.07″. Max. temp. 85°, min. 50°.

PENSACOLA, FLA.: There was a rather cold period 19th through the 25th with daily mean temperature ranging from 11° to 18° below normal. A very small amount of sleet and snow fell on the 24th. Lowest temp. 25° on 23rd.

LITTLE ROCK, ARK.: Outstanding feature was the 11.6″ of snow on 5–6th, this being the second heaviest snow on record for January (heaviest 13″ in 1893). Driving hazardous, but all melted by 10th.

OKLAHOMA CITY, OKLA.: Severe windstorm hit about 0500 on 14th. Considerable damage in downtown area, believed to be funnel aloft. Highest gust at airport 77 mph.

AMARILLO, TEX.: The coldest January since 1949 and the period 16–23rd was the second longest in January with continuous below-freezing temperatures.

CLEVELAND, OHIO: The sunshine for the month was only 12% of possible, equaling the record low established in 1941. Only 2.8″ snow, but 15–20″ in hills to east.

BUFFALO, N. Y.: The first January since 1953 to average above normal. Sunshine only 21% of possible. The navigation season ended on 9th, the latest date on record. Harbor mostly clear of ice on 31st with some floating ice fields observed on the lake.

INDIANAPOLIS, IND.: This was the 4th January since 1885 when only a trace of snow fell. January average snowfall is 5.5″.

CHICAGO, ILL.: January was mild with above normal rainfall and below average snowfall. Minimum temp. was + 6°, the highest January minimum since 1939. Some thunderstorm activity on 12th. A new 24-hour rainfall record for January with 2.86″ on 12th.

DUBUQUE, IOWA: Wettest January on record. 3.75″ on 11–12th was greatest 24-hour rain of any January. Previous wettest January 3.45″ in 1869 and 1861.

MINNEAPOLIS, MINN.: Total number of days with minimum zero or lower so far this season only 5; normal is 18. The least was 4 in 1918–19.

FARGO, N. D.: A cold, windy period ended on 5th; during remainder of month weather generally favorable for seasonable outside activities.

DEVILS LAKE, N. D.: Snowfall was heavy with nearly double the normal amount. The 7.1″ on the 1st was the second greatest of record in 24-hours for month of January. Winds were unusually light, averaging 7.5 mph; this equaled the January record for lightest winds set in 1929.

BILLINGS, MONT.: The outstanding feature of the month was its normality in all meteorological elements.

HELENA, MONT.: As a whole January was a month with fine winter weather. There was no severe weather; winds light except for three dates with 30–40 mph. Sunnier with fewer clouds than normal.

WALLA WALLA, WASH.: Warm chinook winds on night of 28–29th with gusts to 50 mph, melted and evaporated snow cover; sent mercury to 63° on 29th, only one degree less than date record.

PORTLAND, ORE.: The 14.9″ snowfall total was the greatest monthly amount since the record 32.9″ January total in 1950. A depth of 9″ in downtown Portland on 19th closed all schools, created very hazardous driving, and halted most downtown traffic for 2 days.

SANTA MARIA, CALIF.: The low temperature of 21° on the 2nd was the coldest minimum ever recorded in the past 18 years of records.

LOS ANGELES, CALIF.: Mean temperature slightly below normal and rainfall somewhat above. Minimum downtown 38° on 2 & 3rd. Maximum 78° on 29th.

LONG BEACH, CALIF.: There was no *unusual* weather during the month.

CANADIAN HIGHLIGHTS

January 1960 was remarkably normal over most of settled Canada. Both the Pacific coast and eastern Canada reported temperatures slightly above normal, while much of the Prairie Provinces were slightly below. The largest departures in the country were in Labrador and northern Quebec where the January temperatures were more than 8 degrees above normal. Eureka in the N.W.T. was the coldest location in the country, averaging − 33° F, while first reports indicate that a temperature of − 61° at Beaverlodge Lake in northern Saskatchewan was the lowest officially recorded temperature in Canada during January 1960. Mildest conditions prevailed on the Pacific coast of British Columbia where Cape St. James recorded a mean temperature of 42°. Abbotsford and Mission, both in British Columbia's Lower Fraser Valley, and Port Alice on Vancouver Island all reported a high of 60°, the highest in the country.

Snowfall was heavy in many sections of southeastern Canada. In Newfoundland, St. John's Torbay Airport recorded 64″ with at least a trace of snow on every day in the month. In New Brunswick, Moncton had 43″ of snow, 17″ of which fell in 24 hours on the 19th to 20th, a record 24-hour snowfall for January.

The main weather features in much of southern Ontario were the severe ice storms of January 2nd, 12–13 and 16th. The most severe of these storms in the Toronto area occurred on the 12th and 13th, when over an inch of freezing rain fell. Following the disruptive storm of December 26–28th, the effect on power lines and communications was particularly serious. Northwest of Toronto some rural areas were without electric power for several weeks. Another unusual feature of January 1960 was that at Toronto, London, and Windsor, there was not a subzero temperature reading.

In Halifax, the month was the sunniest and windiest January on record. The number of hours of

(*Continued on page 85*)

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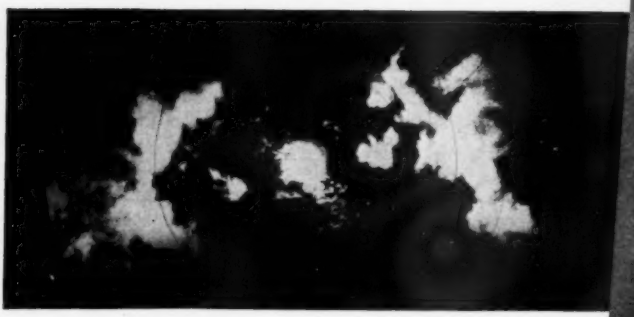

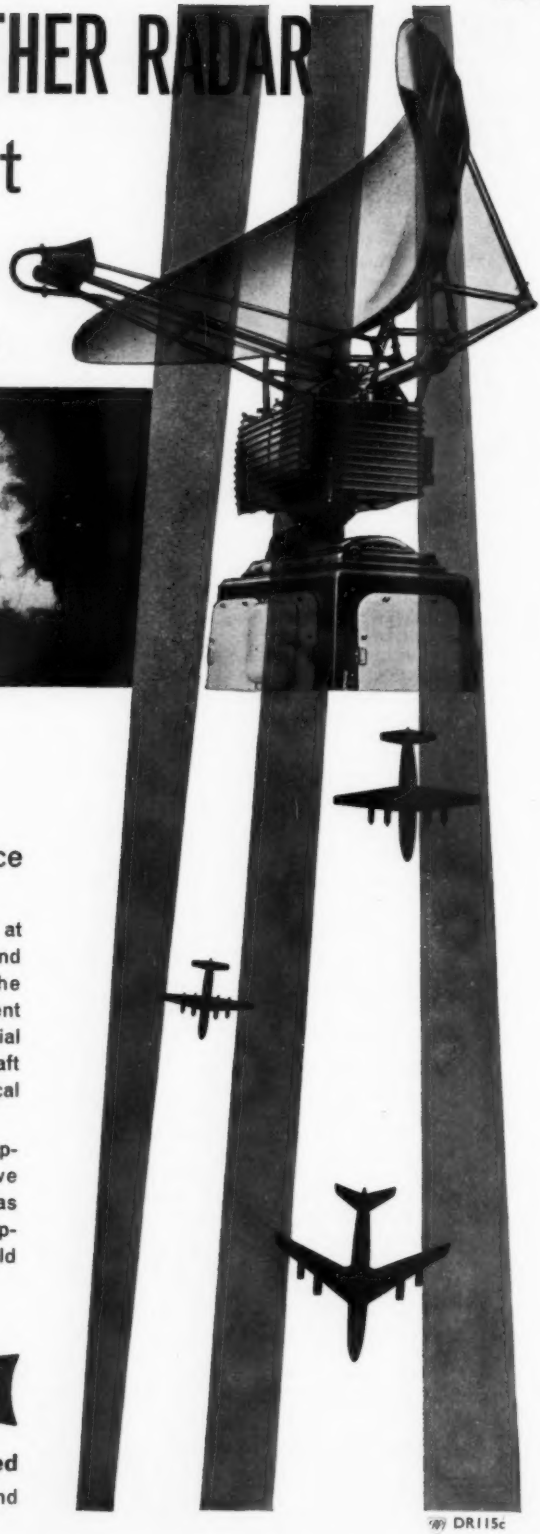

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January (*Continued from page 83*)

bright sunshine were 133 and the average wind speed for the month was 16 mph. In addition a new gust speed record was established of 78 mph. At Regina, Sask., there was a remarkable 50° rise in temperature on January 5 from −34° at midnight to 16° at 1100.

ALASKA NOTES

FAIRBANKS: The month averaged warmer than normal by 6 degrees. Max: 36°, min: −51°. On 13th max: −43°, min: −51°. The snowfall of 23.6″ was 71% more than normal.

JUNEAU: No outstanding departures from the usual January weather. Max: 43°, min: 9°. The 18th marked the last of 64 consecutive days of precipitation.

ANCHORAGE: Temperature of 17° averaged 4 degrees above normal; precipitation of 0.72″ just .04″ below normal. Max: 47°, min: −23°. Snowfall: 14.2″.

BARROW: Mercury above zero on only one day (7th at +3°). Average maxima: −18.7°. Absolute minimum: −45° on 14th; average minima: −30.9°.

ST. PAUL ISLAND: Only one day with below zero, −1° on 31st.

YAKUTAT: The thunderstorm of the 31st, a particularly severe one, is the first ever recorded in January. Max: 45°, min: +4°.

BARTER ISLAND: From 10th to 16th, max. temp. was −29°, absolute min. −45°.

HAWAII NOTES

HONOLULU: Extensive smoke from volcanic activity on the Island of Hawaii 200 miles distant reduced visibility to 3 to 6 miles at this station on the 23rd, and smoky conditions continued through the rest of the month except for a brief clearing on the 27th following a weak frontal passage. A strong temperature inversion near 5000 ft prevented vertical dispersion of the smoke while light winds in the layer below the inversion promoted widespread horizontal dispersion in all directions. Max: 83°, min: 58°. Rainfall: .48″.

HILO: Haze noticeable from Puna Eruption on 18 January to southeast. Haze continual and smoke layers continued from 21 January to 31st and into February. Max: 83°, min: 58°.

LIHUE: The max of 84° equaled the record highest for past 10 years. The total precipitation of 0.97″ was the lowest January total in past 10 years. Haze and smoke appeared on 23rd and lasted to 26th; reappeared on 31st. Max: 84°, min: 57°.

PUERTO RICO NOTES

SAN JUAN: The warmest and driest January on record downtown. The total rainfall, 0.74″, was the smallest total for January in the 62-year record. The monthly mean temperature was the highest in 62 years, two degrees above normal. Max: 88°, min: 69°.

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Glossary (*Continued from page 69*)

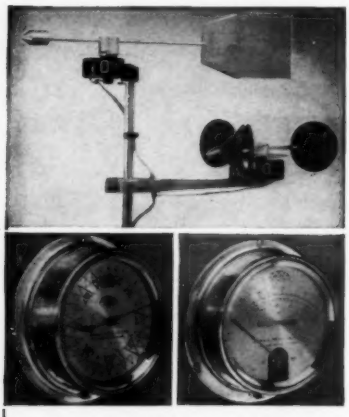
Indian Summer—A period, in mid- or late autumn, of abnormally warm weather, generally clear skies, sunny but hazy days, and cool nights. In New England, at least one killing frost and preferably a substantial period of normally cool weather must precede this warm spell in order for it to be considered a true "Indian summer." It does not occur every year; and in some years there may be two or three Indian summers.

The term is most often heard in the northeastern United States, but its usage extends throughout English-speaking countries. It dates back at least to 1778, but its origin is not certain; the most probable suggestions relate it to the way that the American Indians availed themselves of this extra opportunity to increase their winter stores. The comparable period in Europe is termed the Old Wives summer, and poetically, may be referred to as halcyon days. In England, dependent on dates of occurrence, such a period may be called St. Martin's summer, St. Luke's summer, and formerly All-hallown summer.

Renaissance Meteorology

A Handbook of Renaissance Meteorology by S. K. Heninger, Jr. Duke University Press, Durham, N. C. 1960. $7.50.

Any weary forecaster who may wish to relax from twisted isobars and yet not stray too far from his chosen field will enjoy this admirable volume which reconstructs the metorological knowledge available to the great writers of the Elizabethan and Jacobean period. In the main body of the work, we find a consideration of the following subjects: clouds, rain, hail, snow, mist or fog, dew, frost, thunder and lightning, comets or blazing stars, fiery impressions, the Milky Way, winds, earthquakes, multiple suns and moons, solar and lunar halos, rainbows, eclipses, springs, tides, metals, chasms in the sky, volcanoes, and apparitions in the sky. The final portion of the work is devoted to the metorological imagery of the major creative writers: Spenser, Marlowe, Ben Johnson, Chapman, Donne, and Shakespeare. A short chapter on weather prognostications concludes the study. Dr. Heninger is an ex-Air Force meteorologist and now assistant professor of English at Duke University.



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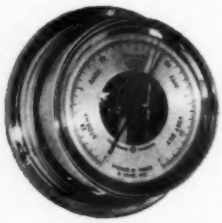

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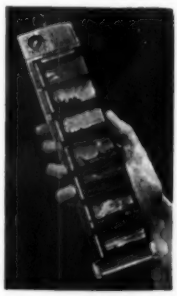

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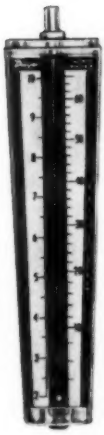

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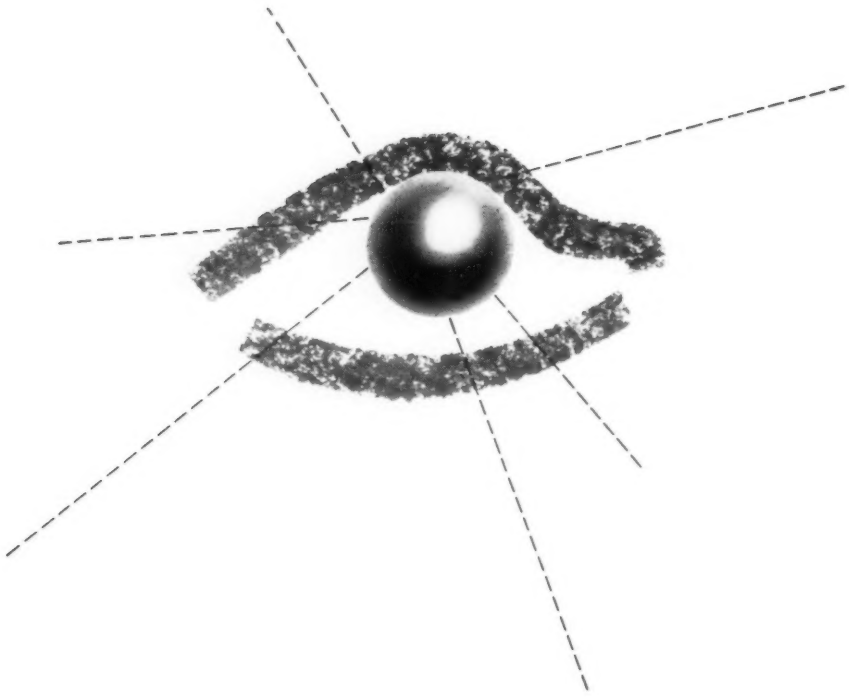

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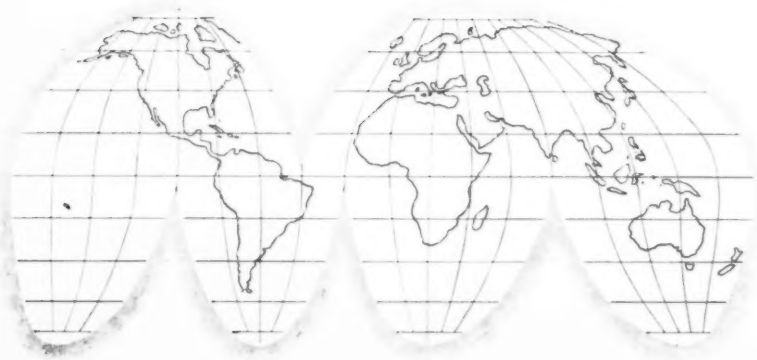
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